Savannah River Site
Solid Waste Management Department
Consolidated Incinerator Facility Project
Operator Training Program

OFFGAS SYSTEM (U)

Study Guide

ZIOITX17

Revision 02

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Training Manager/ Date

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Engineering / Date

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REVISION LOG

REV.	AFFECTED SECTION(S)	SUMMARY OF CHANGE
00	All	Initial issue
01	All	Updated, and reformatted
02	All	Revised, updated, and reformatted

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REFERENCES

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2. *Offgas System Description Document*

3. J-SD-H-00003, *Functional Description, Offgas System* (DA H265)

4. W830315, *Savannah River Site Building 261-H Area 200-H Scrubber Proc. Serv. PPG & Instr. Diag. Process & Instruments (U),* Rev. 26

5. W830316, *Savannah River Site Building 261-H Area 200-H Quench Recirc. Tank Proc. Serv. PPG & Instr. Diag. Process & Instruments (U),* Rev. 31

6. W830317*, Savannah River Site Building 261-H Area 200-H Cyclone Separator & Mist Elim. Proc. Serv. PPG & Instr. Diag. Process & Instruments (U),* Rev. 22

7. W830318, *Savannah River Plant Building 261-H Area 200-H Scrubber Recirc. Tank Proc. Serv. PPG & Instr. Diag. Process & Instruments (U),* Rev. 30

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24. *261-SOP-CAUS-01, Caustic (U),* Rev. 1

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26. *261-SOP-OGB-01, Offgas Blowdown (U),* Rev. 2

27. *261-SOP-OGE-01, Offgas Exhaust (U),* Rev 5

28. *261-SOP-OGQ-01, Offgas Quench (U),* Rev. 6

29. *261-SOP-OGS-01, Offgas Scrubber (U),* Rev. 4

30. *261-SOP-RMAC-01, Raw Material Acceptance Criteria (U),* Rev. 1

31. *261-AOP-OG-01, OFFGAS Events (U),* Rev. 0

32. *261-ROOR-01,), Rover Outside Operator Rounds (U),* Rev. 0

33. *261-ROR-01 R S, ,Regulatory Operator Rounds R S,* Rev. 4

34. *261-SUR-OG-01, Tank Sampling For Laboratory Analysis (U),* Rev. 0

LEARNING OBJECTIVES

TERMINAL OBJECTIVE

1.0 Without references, **EXPLAIN** the significance of the OFFGAS SYSTEM to Consolidated Incinerator Facility operations, including its importance to safety, and the impact on operations of a failure of the system.

ENABLING LEARNING OBJECTIVES

1.01 **STATE** the purpose of the OFFGAS System.

1.02 Briefly **DESCRIBE** how the OFFGAS System accomplishes it's intended purpose.

1.03 **EXPLAIN** the consequences of a failure of the OFFGAS System to fulfill it's intended purpose, including the effects on other systems or components, overall plant operation, and safety.

TERMINAL OBJECTIVE

2.0 Using system diagrams, **EVALUATE** potential problems that could interfere with normal OFFGAS System flowpaths to determine their significance on overall system operation and the corrective actions needed to return the system to normal.

ENABLING LEARNING OBJECTIVES

2.01 **DESCRIBE** the physical layout of the OFFGAS System components including, the general location, how many there are, and functional relationship for each of the following major components.

a. Pumps

b. Tanks

c. Thermosyphons

2.02 **DESCRIBE** the OFFGAS System arrangement to include a drawing showing the following system components and interfaces with other systems:

a. OFFGAS Quench

b. OFFGAS Scrubber

c. OFFGAS Exhaust

d. OFFGAS Blowdown

2.03 Given a description of the OFFGAS System equipment status, **IDENTIFY** conditions which interfere with normal system flowpaths.

2.04 Given a description of abnormal equipment status for the OFFGAS System, **EXPLAIN** the significance of the condition on system operation.

2.05 Given a description of the OFFGAS System equipment status, **STATE** any corrective actions required to return system operation to a normal condition.

TERMINAL OBJECTIVE

3.0 Given values of OFFGAS System operation parameters, **EVALUATE** potential problems that could effect the normal functioning of the system or it's components to determine the significance of the existing condition and the actions required to return the system to normal operation.

ENABLING LEARNING OBJECTIVES

3.01 **DESCRIBE** the following major components of the OFFGAS System including their functions, principles of operation, and basic construction:

a. Quench Vessel

b. Steam Hydro Scrubber

c. Cyclone Separator

d. Mist Eliminator

e. Reheater

f. HEPA Filters

g. Induced Draft Fans

h. Stack Monitoring

i. Crossflow Slurry Filter

3.02 **STATE** the design capacities and operational limitations for the following OFFGAS System major components:

a. Quench Separation Tank

b. Quench Recirculation Tank

c. Quench Recirculation Pumps

d. Scrubber Recirculation Tank

e. Scrubber Recirculation Pumps

f. Damper

g. Filter Feed Tank

h. Filter Feed Pumps

I. Transfer pump

j. Blowdown Tanks 1 & 2

k. Blowdown Transfer Pumps 1& 2

l. Caustic Metering Transfer Pumps

m. Caustic Storage Tank

3.03 Given values for key performance indicators, **DETERMINE** if OFFGAS System components are functioning as expected.

3.04 **DESCRIBE** the following OFFGAS System instrumentation including, indicator location (local or Control Room) sensing points and associated instrument controls.

a. Flow and Density

b. Pressure

c. Temperature

d. pH and Conductivity

e. Level and Specific Gravity

f. Stack Emissions

3.05 **INTERPRET** the following OFFGAS System alarms, including the conditions causing alarm actuation and the basis for the alarms:

a. Flow and Density

b. Pressure

c. Temperature

d. pH and Conductivity

e. Level and Specific Gravity

f. Stack Emissions

3.06 **EXPLAIN** how the following OFFGAS System equipment is controlled in all operating modes or conditions to include: control locations (local or Control Room), basic operating principles of control devices, and the effects of each control on the component operation.

a. Major Equipment

b. Pumps

c. Valves

d. Tanks

3.07 **DESCRIBE** the interlocks associated with the following OFFGAS System equipment to include the interlock actuating conditions, effects of interlock actuation, and the reason the interlock is necessary.

a. Quench Vessel

b. Steam Hydro Scrubber

c. Quench Recirculation Pumps

d. Scrubber Recirculation Pumps

e. Induced Draft Fans

f. Caustic Pumps

TERMINAL OBJECTIVE

4.0 Given necessary procedures or other technical documents and system conditions, **DETERMINE** the operator actions required for normal and off normal operation of the OFFGAS System including problem recognition and resolution.

ENABLING LEARNING OBJECTIVES

4.01 **STATE** the personnel safety concerns associated with the OFFGAS System.

4.02 Given applicable procedures and plant conditions, **DETERMINE** the actions necessary to perform the following OFFGAS System operations;

a. Normal Startup

b. Normal/abnormal operation

c. Normal Shutdown

d. Mandatory Shutdown

e. Emergency Shutdown

4.03 **DETERMINE** the effects on the OFFGAS System and the integrated plant response when given any of the following:

a. .Indications/alarms

b. Malfunctions/failure of components

c. Operator Actions

SYSTEM OVERVIEW

ELO 4.01	**STATE the personnel safety concerns associated with the OFFGAS System.**

Safety

The personnel safety concerns associated with the OFFGAS System include hazards common to operating industrial plants and chemical hazards unique to the Consolidated Incinerator Facility (CIF) OFFGAS system.

The industrial hazards are noise, rotating equipment, electrically powered components, exposed hot surfaces, slipping, and tripping. Some responses to these hazards follow. Hearing protection must be worn. Chains, necklaces, or loose articles of clothing should not be worn in the vicinity of rotating equipment. Proper electrical safety precautions must be adhered to when operating electrical equipment. Gloves should be worn when working with mechanical equipment and piping. Extra precautions should be taken during times of extreme temperatures or rain when working in the Offgas System area.

The two most important chemical hazards unique to the CIF OFFGAS process are from the use of caustic, and from the accumulation of heavy metals in the HEPA filters. Caustic (NaOH) solution, upon contact with eyes or skin, can cause blindness and skin burns. Inhaled or ingested heavy metals in minute quantities can be fatal. All procedural and safety manual precautions must be observed when working with chemicals in the Offgas area.

Personnel Safety is an operator first responsibility and priority. Compliance to *WSRC 4Q, Industrial Hygiene Manual*, and *WSRC 8Q, Employee Safety Manual* is mandatory. Both manuals are located in the CIF control room.

ELO 1.03	**EXPLAIN the consequences of a failure of the OFFGAS System to fulfill it's intended purpose, including the effects on other systems or components, overall plant operation, and safety.**

Introduction

The incineration of waste materials, regardless of the types, requires the use of air pollution control devices or offgas systems. The ability to properly clean offgas of potentially harmful contaminants, prior to release to the atmosphere, is legally required and necessary to protect health and the environment, and gain public acceptance.

The OFFGAS System consists of four subsystems and a support system. The four sub-systems are OFFGAS Quench (OGQ), OFFGAS Scrubber (OGS), OFFGAS Exhaust (OGE), and OFFGAS Blowdown (OGB). The support system is the Caustic System.

Some of the more significant by products of the incineration process that the offgas system is designed to filter and/or remove are:

- Hydrocarbons
- CO
- Particulate
- Acid gases
- NOx
- Volatile metals
- Radionuclides

Equipment malfunction and/or operator error that interfere with the proper operation of the OFFGAS system may result in shutting down the incinerator and/or releasing radioactive and toxic material to the atmosphere. Deliberate operator actions that cause permit violations could result in legal action taken against individual operators. For further information see the Price - Warner Act.

SYSTEM PURPOSE

ELO 1.01	**STATE the purpose of the OFFGAS System.**
ELO 1.02	**Briefly DESCRIBE how the OFFGAS System accomplishes it's intended purpose.**

Purpose

The purpose of the OFFGAS System is to minimize the release of radionuclides and blowdown wastes. This purpose is accomplished by:

- reducing the flue gas temperature to within 4° F of saturation temperature;
- capturing sub-micron particulates and filtering out absorbable acids and toxins from the flue gas;
- maintaining sub-atmospheric pressure on process equipment to ensure confinement of flue gas throughout the treatment process;
- filtering radionuclides and heavy metals from the flue gas;
- sampling, analyzing, and documenting the stack emissions;
- collecting and concentrating solids removed from the flue gas.

DESCRIPTION AND FLOWPATH

Primary Offgas Flowpath

The flue gas exiting the SCC. averages a flue gas flow of 33,172 ACFM (actual cubic feet per minute) at 2012°F or 32,039 pounds per hour. Table 1, Flue Gas Composition, provides a breakdown of the expected contents of the flue gas during full operations

COMPONENT	PERCENTAGE (%)
Nitrogen (N2)	70.4
Oxygen (O2)	10.2
Carbon Dioxide (CO2)	11.2
Water Vapor (H2O)	6.2
Chlorides (HCl or Cl2)	1.4
Sulfur Dioxide (SO2)	.000008
Phosphorus Pentoxide (PO5)	.0000075
Ash Particulates	.5
Total Flow	

Table 1 - Flue Gas Composition

The flue gas exiting the stack will average 20,400 ACFM at 200 F to 240 F. Table 2, Exit Flue Gas Composition, provides a breakdown of the change in percentage in the make up of the flue gas.

COMPONENT	PERCENTAGE (%)
Nitrogen (N2)	> 70.4
Oxygen (O2)	> 10.2
Carbon Dioxide (CO2)	< 11.2
Water Vapor (H2O)	< 6.2
Chlorides (HCl or Cl2)	<< .0001
Sulfur Dioxide (SO2)	< .000008
Phosphorus Pentoxide (PO5)	<.0000075
Ash Particulates	<<. 05
Total Flow	

Table 2 - Exit Flue Gas Composition

The Offgas System primary flowpath consists of a Quench Vessel, Steam-jet Scrubber, Cyclone Separator, Mist Eliminator, Reheater, High Efficiency Particulate Air (HEPA) Filters, Induced Draft (ID) Fans, and stack. A simplified flowpath through the major components of the system is shown on Figure 1, Offgas System Simplified Flowpath.

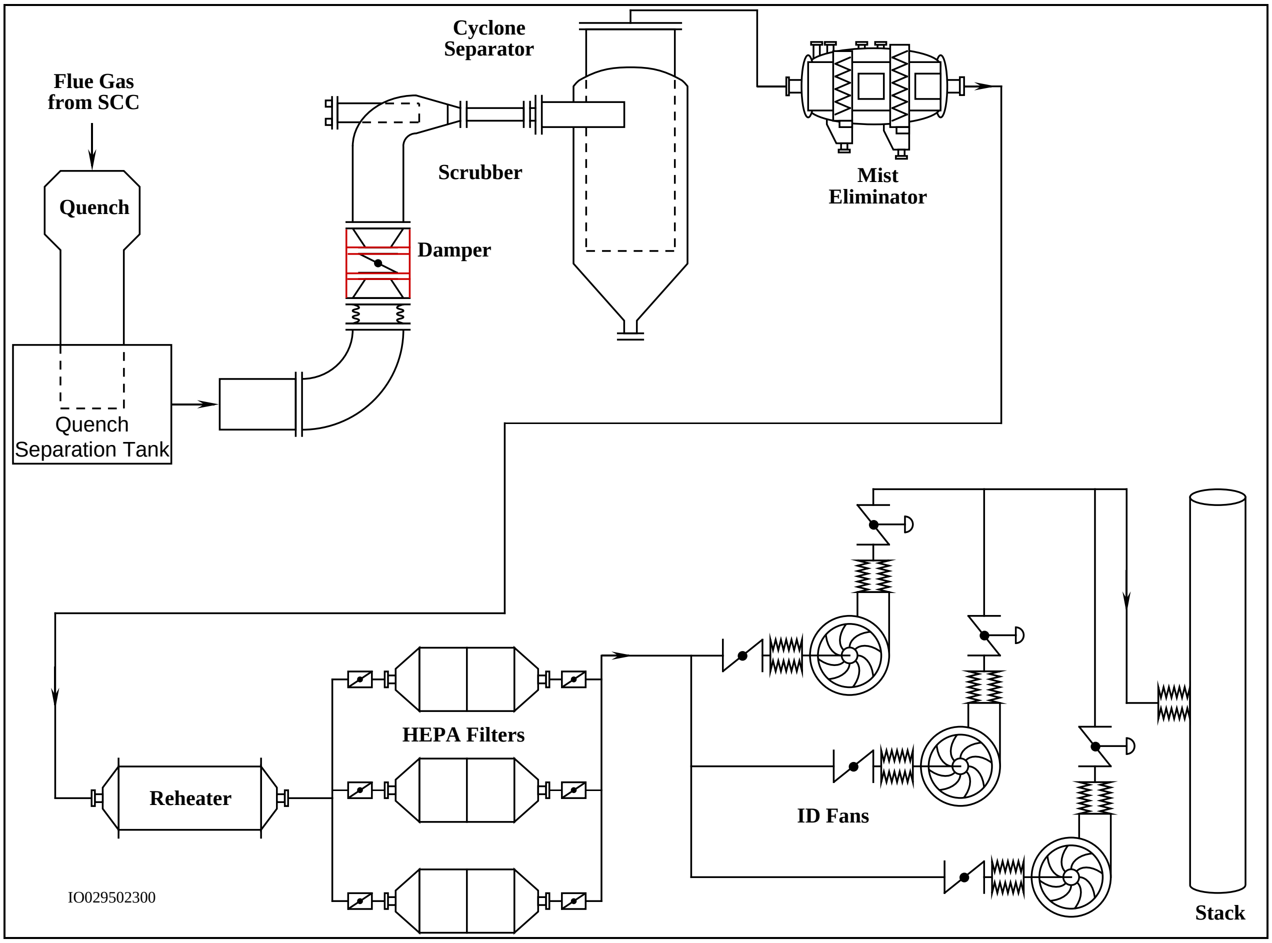


Figure 1 Offgas System Simplified Flowpath

A complete flowpath of the Offgas System is shown on Figures 2 and 3 Offgas System Block Diagram Sheet 1 and 2. (Note: Letters A through K on Figures 2 and 3 are match lines.)

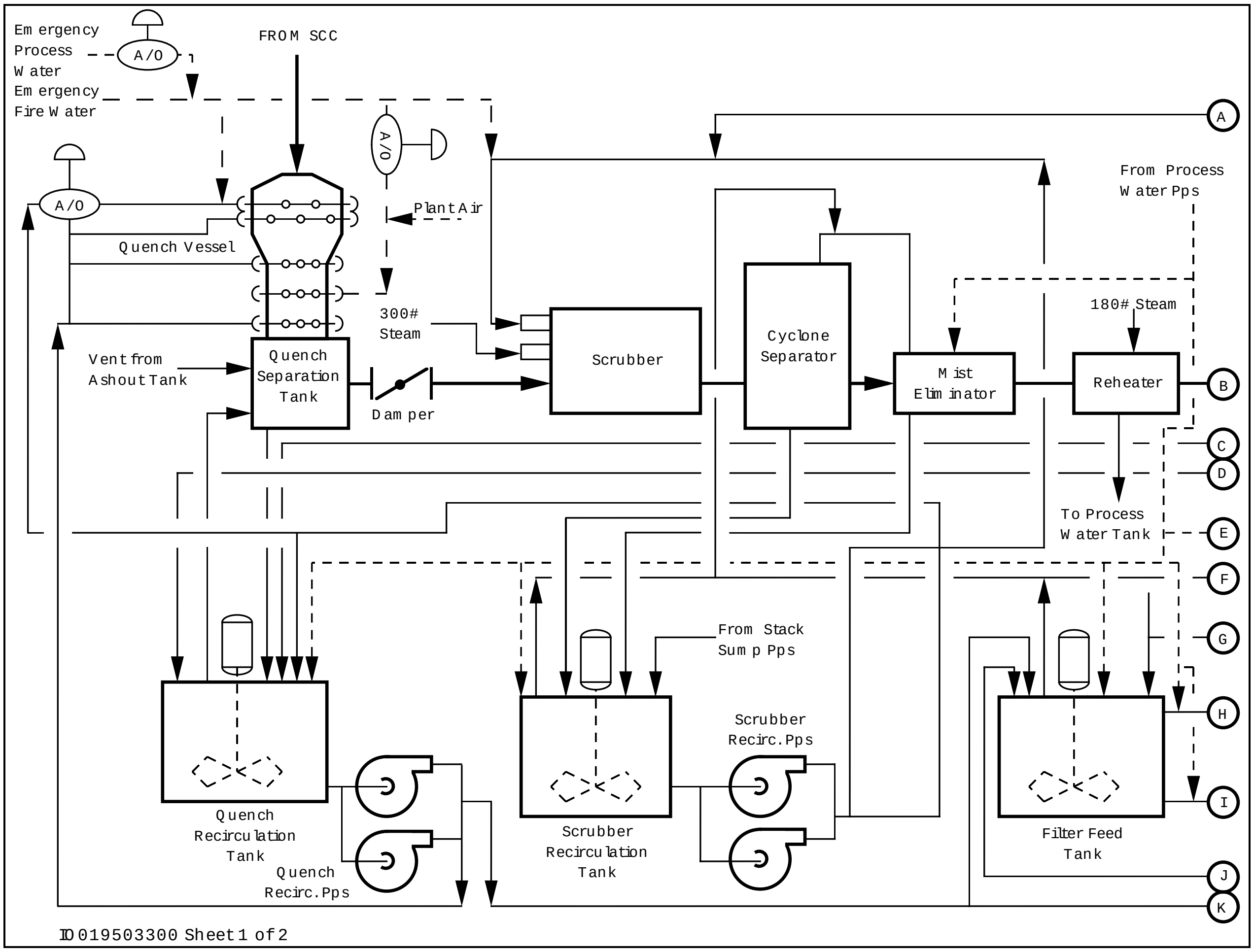


Figure 2 - Offgas System Block Diagram Sheet 1

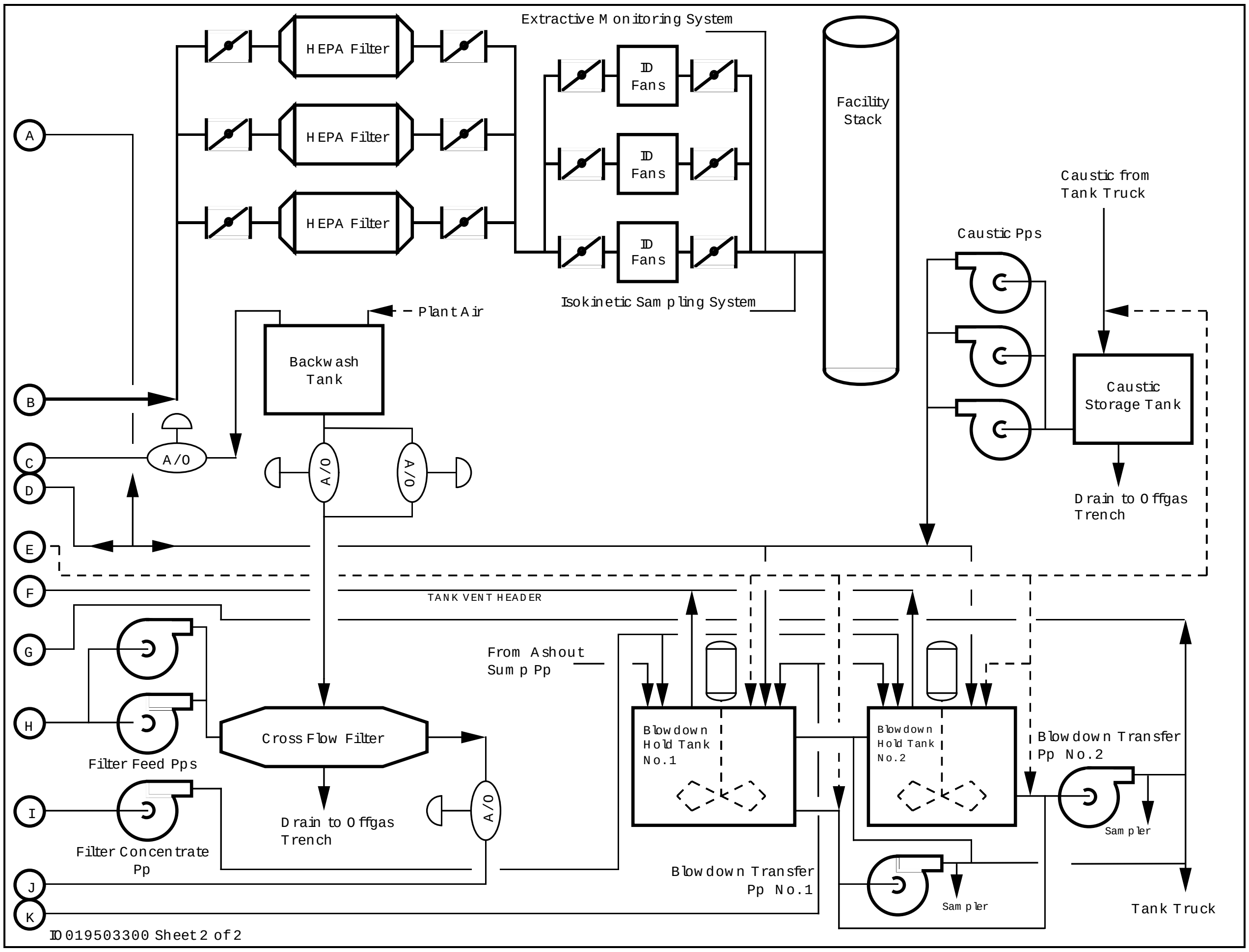


Figure 3 - Offgas System Block Diagram Sheet 2

ELO 1.02	**Briefly DESCRIBE how the OFFGAS System accomplishes it's intended purpose.**
ELO 2.01	**DESCRIBE the physical layout of the OFFGAS System components including, the general location, how many there are, and functional relationship for each of the following major components:** **a. Pumps** **b. Tanks** **c. Thermosyphons**
ELO 2.02	**DESCRIBE the OFFGAS System arrangement to include a drawing showing the following subsystem components and interfaces with the other offgas subsystems:** **a. OFFGAS Quench** **b. OFFGAS Scrubber** **c. OFFGAS Exhaust** **d. OFFGAS Blowdown**
ELO 2.03	**Given a description of the OFFGAS System equipment status, IDENTIFY conditions which interfere with normal system flowpaths.**
ELO 2.04	**Given a description of abnormal equipment status for the OFFGAS System, EXPLAIN the significance of the condition on system operation.**
ELO 3.01	**DESCRIBE the following major components of the OFFGAS System including their functions, principles of operation, and basic construction:** **a. Quench Vessel**

Offgas Quench (OGQ)/

The Offgas Quench System is shown in Figure 4, Offgas Quench. The system consists of a quench vessel, five spray rings (four for normal use and one for emergency), a separation tank, a quench recirculation tank, two quench recirculation pumps, redundant pH and conductivity monitors and transmitters, and associated instrumentation and controls. The primary purpose of the system is to reduce the offgas temperature to within 4°F of saturation temperature

Quench Vessel/ Separation Tank

Flue gas enters the quench vessel where it is cooled by approximately 360 gallons per minute (gpm) of quench recirculation liquid. The gases flow down and mix with the quench liquid in a turbulent environment. The gases then flow to the separation tank where the quench liquid is gravity separated from the cooled offgases. Approximately 25 to 30 gpm of the quench recirculation is evaporated by the offgas. The offgas flow leaves the separation tank and proceeds to the scrubber for further processing.

The liquid removed in the Quench Separation Tank drains to the Quench Recirculation Recirc Tank. Approximately 360 gpm total flow to the Quench Spray rings is provided from the Quench Recirc Tank by one of two Quench Recirc Pumps and a scrubber recirc pump. Makeup to the system (to compensate for evaporation) is provided from the Offgas Scrubber System through a 3-way mixing valve (OGS-LCV-3100(B) into the top spray header. Makeup flow rate is controlled as a function of Quench Recirc Tank level. Makeup from the Offgas Scrubber System directly to the Quench Recirc Tank is possible, by DCS selection.

In the event of high temperature downstream of the Quench Vessel, or the loss of the quench recirc pumps, service and/or fire water is supplied to the emergency spray header and the top spray header. When the Service Water and/or Fire Water valves open this automatically actuates an incinerator shutdown.

Quench Recirc Tank and Pumps

The Quench Recirc Tank and one of two pumps supply cooling solution to the Quench Vessel through the first, second, third and fifth spray rings. The Quench Recicr Tank also serves to maintain solids in suspension and will blowdown to the Filter Feed Tank or Blowdown Hold Tank on a high density (> 3% solids) or high conductivity (>10% Total Dissolved Solids) signal. This function is necessary to prevent the spray nozzles in the Quench Vessel from plugging. At average operation this would result in thirty (30) minutes blowdown at ten (10) gpm every four (4) hours. The blowdown to the Filter Feed Tank or the Blowdown Tank is selectable by the operator. During blowdown, flow in the blowdown line must be maintained between 10 to 20 gpm to prevent solids from settling that could eventually plug the line

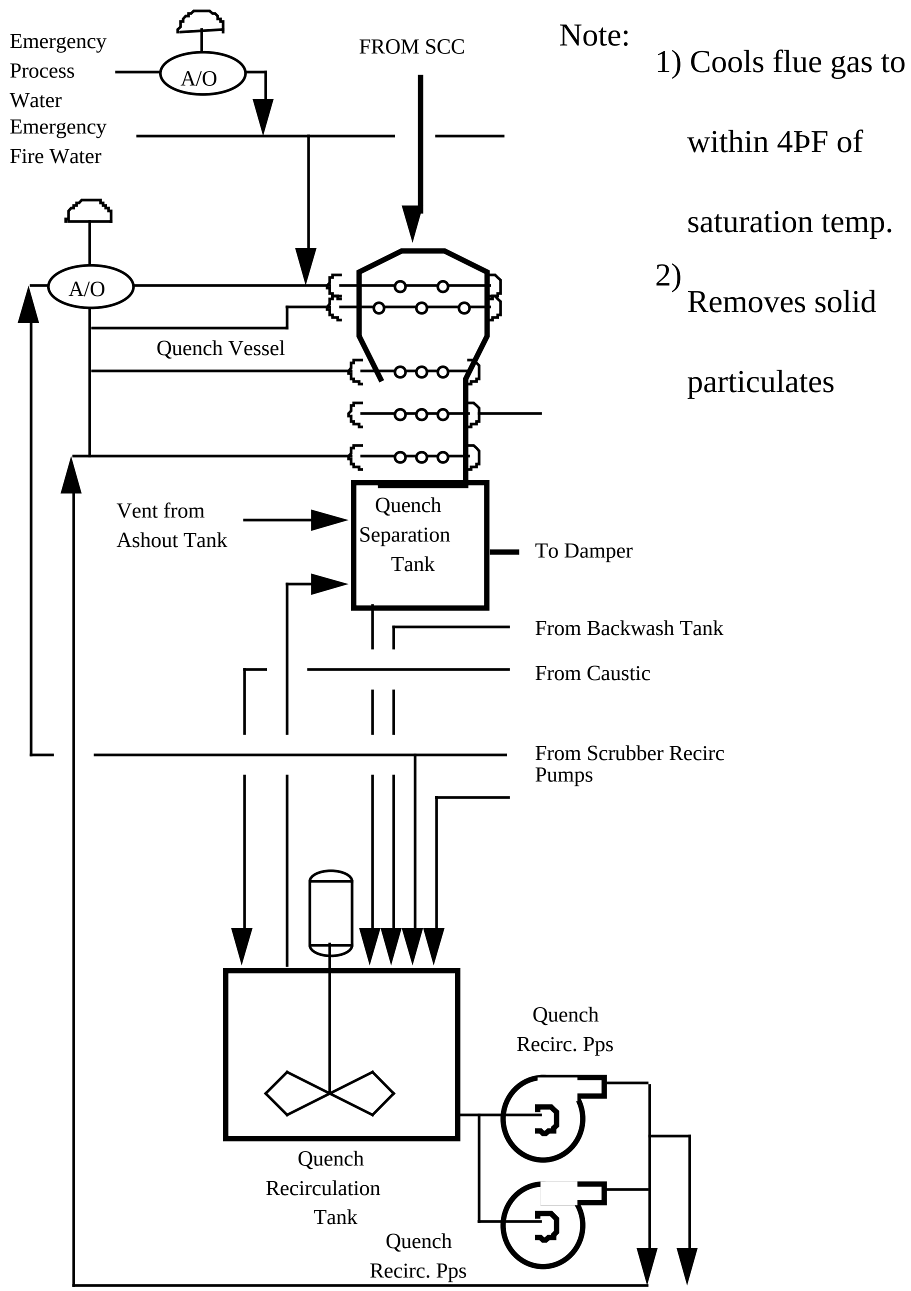


Figure 4 , Offgas Quench Flowpath

ELO 1.02	**Briefly DESCRIBE how the OFFGAS System accomplishes it's intended purpose.**
ELO 2.01	**DESCRIBE the physical layout of the OFFGAS System components including, the general location, how many there are, and functional relationship for each of the following major components:** **a. Pumps** **b. Tanks** **c. Thermosyphons**
ELO 2.02	**DESCRIBE the OFFGAS System arrangement to include a drawing showing the following subsystem components and interfaces with the other offgas subsystems:** **a. OFFGAS Quench** **b. OFFGAS Scrubber** **c. OFFGAS Exhaust** **d. OFFGAS Blowdown**
ELO 2.03	**Given a description of the OFFGAS System equipment status, IDENTIFY conditions which interfere with normal system flowpaths.**
ELO 2.04	**Given a description of abnormal equipment status for the OFFGAS System, EXPLAIN the significance of the condition on system operation.**
ELO 3.01	**DESCRIBE the following major components of the OFFGAS System including their functions, principles of operation, and basic construction:** **b. Steam Hydro Scrubber** **c. Cyclone Separator** **d. Mist Eliminator**

Offgas Scrubber System (OGS)

The Offgas from the Quench Separation Tank enters the Scrubber for removal of ash particulates, salt particulates, chlorides, and sulfur dioxide. The system consists of a pressure control damper, a steam-jet scrubber (Figure 5, Offgas Scrubber), a cyclone separator, a mist eliminator, a recirculation tank, two recirculation pumps, redundant pH and conductivity monitors and transmitters, and associated instrumentation and controls. This combination of components provides a highly efficient means of capturing particulates down to the sub-micron range and for removal of absorbable acids and toxins.

Scrubber

The scrubber includes a steam ejector nozzle and water ring to generate a high velocity mixing of scrubber solution with the offgas. Scrubbing liquid and caustic are introduced at the ejector throat where a sonic shock wave is developed,. breaking up the scrubbing liquid into fine droplets. The droplets capture the particulates down to the sub-micron range and absorb the acid gases. The fine droplets containing the particulates are combined in the mixing tube, located downstream of the scrubber, into layer droplets.

The steam ejector nozzle also provides suction to promote the flow of the offgas. At normal offgas flow rates, the vacuum at the Quench Separation Tank is approximately 3 inches water column (INWC). Induced Draft (ID) Fans draw initial vacuum on the system and the pressure control damper (FCD-1704) is used to maintain Rotary Kiln (RK) and Offgas System pressures at a slight vacuum (~0.5 INWC) to prevent leakage of contaminants to the atmosphere.

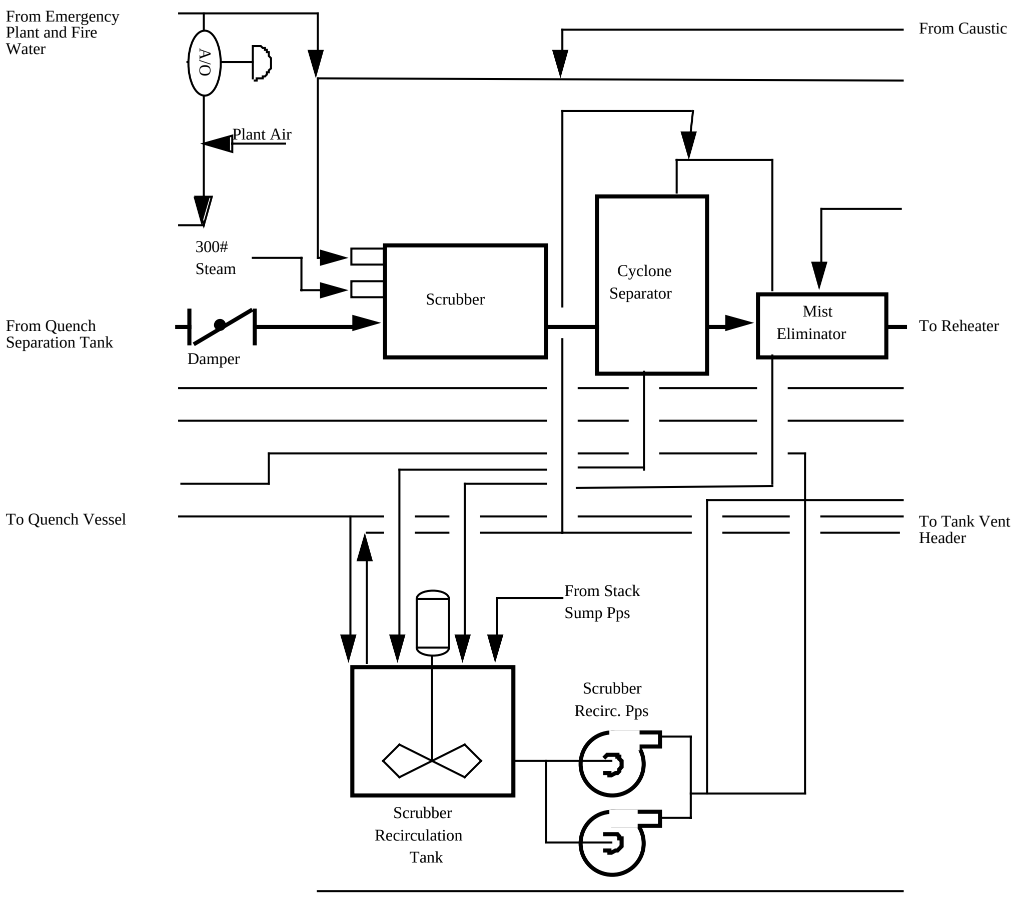
Caustic is added to the scrub solution to reduce the acidic nature of the offgas. This reduction protects up stream equipment from damage. The offgas from the incinerator is acidic in composition as a result of the combustion process.

Cyclone Separator and Mist Eliminator

The scrub solution and entrained particulates are collected in the Cyclone Separator. The Cyclone Separator is designed to remove entrained moisture from the saturated offgas by centrifugal force. Additional liquid droplets (greater than 5 microns in size) are removed from the offgas in the Mist Eliminator.

Scrubber Recirc Tank and Pumps

Both the Cyclone Separator and the Mist Eliminator drain to the Scrubber Recirc Tank. The Scrubber Recirculation Tank also serves to maintain solids in suspension. The Scrubber Pumps receive a suction from the tank and supply the scrub solution to the scrubber as well as the normal makeup (27.5 gpm) to the OGQ spray header. Makeup can be directed to the OGQ Recirculation Tank if selected on DCS. Makeup to the Scrubber Recirculation Tank includes service water from the Mist Eliminator (wash water) and direct makeup to the Scrubber Recirculation Tank from the Service Water System. Mist Eliminator wash is manually controlled while the service water addition to the recirculation tank is controlled by Scrubber level. Additionally, liquid can be added from the stack sump, Offgas sump, and Bldg. sumps 1, 2 and 3.



Notes:
1) Removes liquids with particulates down submicron level
2) Absorbs acid gases and toxins

Figure 5 Offgas Scrubber Flowpath

ELO 1.02	**Briefly DESCRIBE how the OFFGAS System accomplishes it's intended purpose.**
ELO 2.01	**DESCRIBE the physical layout of the OFFGAS System components including, the general location, how many there are, and functional relationship for each of the following major components:** **a. Pumps** **b. Tanks** **c. Thermosyphons**
ELO 2.02	**DESCRIBE the OFFGAS System arrangement to include a drawing showing the following subsystem components and interfaces with the other OFFGAS subsystems:** **a. OFFGAS Quench** **b. OFFGAS Scrubber** **c. OFFGAS Exhaust** **d. OFFGAS Blowdown**
ELO 2.03	**Given a description of the OFFGAS System equipment status, IDENTIFY conditions which interfere with normal system flowpaths.**
ELO 2.04	**Given a description of abnormal equipment status for the OFFGAS System, EXPLAIN the significance of the condition on system operation.**
ELO 3.01	**DESCRIBE the following major components of the OFFGAS System including their functions, principles of operation, and basic construction:** **e. Reheater** **f. HEPA Filters** **g. Induced Draft Fans** **h. Stack Monitoring**

Offgas Exhaust System (OGE)

The OGE System consists of a Reheater, three HEPA Filters arranged in parallel, three ID Fans and stack monitoring (Opacity, Oxygen and Carbon Monoxide). (See Figure 6, Offgas Reheater and HEPA Filters). The Reheater increases the temperature of the offgas to prevent condensation from occurring downstream on the carbon steel duct or HEPA Filters. The purpose of the HEPA filters is to remove 99.97% of the remaining particles greater than 0.3 microns. Induced Draft Fans (ID fans) maintain the offgas system at a vacuum to confine and move the flue gas through to the stack.

Reheater

Offgas from the Mist Eliminator is directed to the Reheater through a 46-inch duct. Steam is provided to three Reheater heating coils at 180 psig. Two of the coils are in operation continuously and one is used as a backup. The temperature of the offgas is increased to 250°F. The minimum operating outlet temperature of the Reheater is 200° F to help minimize condensation in the HEPA Filters. The steam supply is provided with a redundant control valve so that routine servicing can be done on the valve without system shutdown. Condensate drains can be routed to the Service Water tank however, they are normally routed to the drain system.

HEPA Filter

The offgas from the Reheater is routed through a 36-inch diameter duct that reduces to three 30-inch ducts for parallel flow through the HEPA Filter Banks. Two of the three HEPA Filter Banks are in continuous operation with the third being used as a backup. Each of the HEPA Filter Banks typically operate at a gas flow rate of 9000 ACFM at 240°F

Induced Draft (ID) Fans

Offgas from the HEPA Filters is directed to the ID Fans through a 36-inch duct. There are three fans with two normally in continuous operation and one serving as backup. The operator will determine the number of fans in operation at any particular time based on flue gas flow and if the control damper(s) is maintaining a consistent flue gas flow. The flue gas flow rate is expected to vary over the period between solid waste additions.

The fans are designed to handle the maximum required flow rates with the integral dampers normally used to control the duct pressure thereby controlling the flow rates when less than the maximum value is required. This will prevent cycling the fans as flow requirements change. Under normal operation, the ID Fans are started and stopped manually.

The ID Fan integral discharge dampers go to the closed position in the starting sequence to prevent an overcurrent trip of the respective Fan on starting. The isolation Damper (H-261-OGE-FCD-3505, H-261-OGE-FCD-3506, and H-261-OGE-FCD-3503) on the fan outlet, opens automatically when the fan is running and closes when the fan is shutdown. Fans are shut down when not required to meet flow demands or when the incinerator is shut down. The ID Fans are also equipped with vibration switches that automatically shut down the fans on a high vibration indication or in the event of a mechanical failure. If a fan is shutdown on a high vibration indication, an alarm will activate on the DCS and any fans aligned in a standby mode will automatically start.

Stack Monitoring

The extractive monitoring system samples the offgas continuously on its way to the stack. Carbon Monoxide (CO) and Oxygen (O2) levels are determined in the offgas using extractive monitors to detect levels in excess of State and Federal emissions requirements. Measurements of CO and O2 also provide indication of complete combustion in the incinerator. When the burners are lit, electrical and instrument (E&I) maintenance must calibrate this equipment daily per RCRA requirements. Operators use the DCS to select the operating unit and provide readings for the other being calibrated.

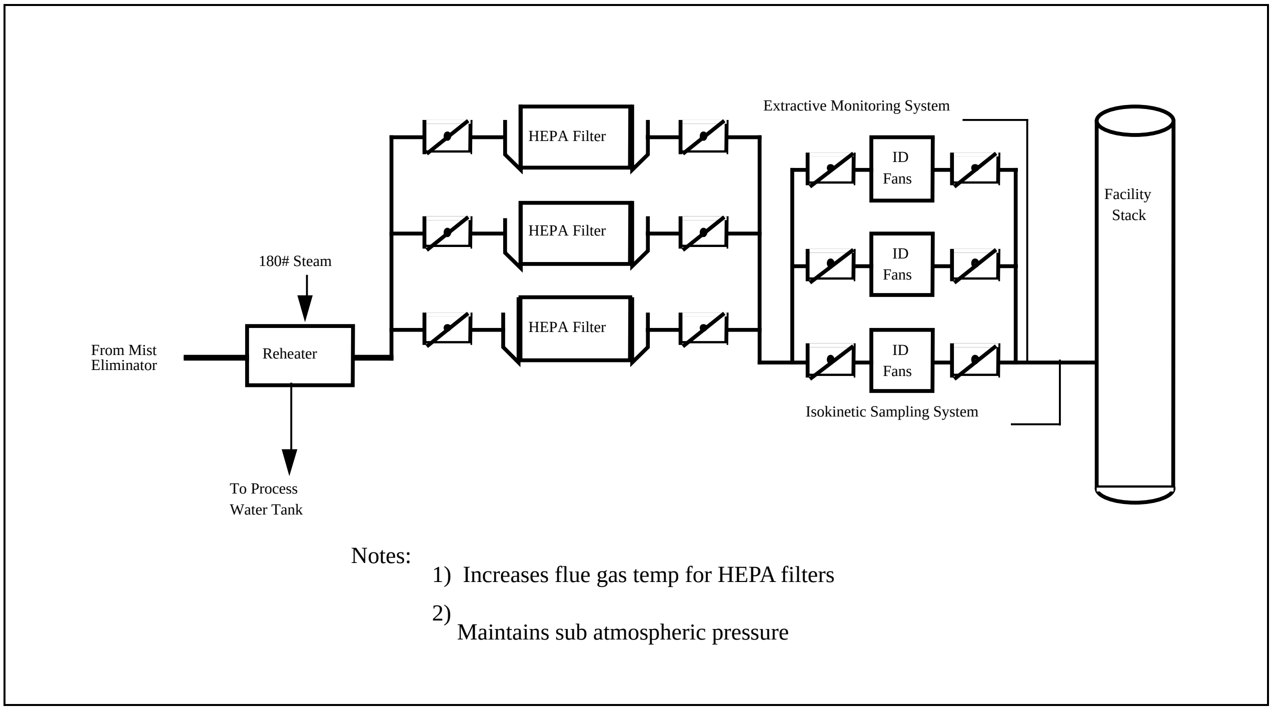


Figure 6- Offgas Exhaust System

ELO 1.02	**Briefly DESCRIBE how the OFFGAS System accomplishes it's intended purpose.**
ELO 2.01	**DESCRIBE the physical layout of the OFFGAS System components including, the general location, how many there are, and functional relationship for each of the following major components:** **a. Pumps** **b. Tanks** **c. Thermosyphons**
ELO 2.02	**DESCRIBE the OFFGAS System arrangement to include a drawing showing the following subsystem components and interfaces with the other offgas subsystems:** **a. OFFGAS Quench** **b. OFFGAS Scrubber** **c. OFFGAS Exhaust** **d. OFFGAS Blowdown**
ELO 2.03	**Given a description of the OFFGAS System equipment status, IDENTIFY conditions which interfere with normal system flowpaths.**
ELO 2.04	**Given a description of abnormal equipment status for the OFFGAS System, EXPLAIN the significance of the condition on system operation.**
ELO 3.01	**DESCRIBE the following major components of the OFFGAS System including their functions, principles of operation, and basic construction:** **i. Crossflow Slurry Filter**

Offgas Blowdown (OGB)

The primary purpose of the Offgas Blowdown Subsystem is to minimize the volume of waste that must be disposed of by collecting and concentrating the solids removed from the flue gas. The control room operator uses DCS to select the quench system blowdown flowpath. Usually this flowpath is through the crossflow filter, but it can also be directed to a selected blowdown tank. Both the offgas filtration flowpath and the blowdown flowpath are described below.

Offgas Filtration Flowpath

The Offgas Filtration flowpath consists of a Filter Feed Tank, two Filter Feed Pumps (Figure 7, Offgas Blowdown), a Crossflow Filter, and a Backwash Tank. The filtration flowpath provides for reduction of undissolved solids in the OGQ. Quench blowdown liquid is directed to the Filter Feed Tank where it is pumped to the Crossflow Filter (a shell containing long sintered tubes) The filtration actions involved are as follows:

- Normal filtering action due to fluid flow through the porous metal.
- The high fluid velocity imparts a high kinetic energy to the larger particles which makes it difficult for the particles to be pulled into the porous wall.
- Particles tend to become concentrated in the center of the tube as a result of particle spin induced by the velocity gradient across the tube inside diameter.

These filtration actions result in the formation of a subsurface membrane made up of very fine particulate. This subsurface membrane acts as a filter of much finer porosity than that of the porous tube, allowing an extremely high degree of filtration to be achieved. Or put in other words, because of the differential pressure across the tubes liquid in the flow passes through the tube walls and solid materials discharge from the tube ends and out the filter discharge line. The "clean" filtrate is returned to the Quench Recirc Tank and the solution containing the concentrated solids is returned to the Filter Feed Tank.

For the average design flow, the Crossflow Filter will be operated continuously with a filtrate return rate to the OGQ System of 0.4 gpm. A back pressure control valve (H-261-OGB-PCV-3716) in the filter recirculation line maintains the concentrate side of the filter at 60 psig, and a flow control valve (H-261-OGB-FCV-3711) in the filtrate line maintains constant filtrate flow. Filtrate flow is routed through the Backwash Tank (H-261-OGB-TK-004). Liquid collected in the Backwash Tank is used for backwashing the filter. Filter backwash is automatically controlled by filtrate control valve position and filtrate flow rate. If the filtrate valve is full open and a minimum filtrate flow rate (.35 gpm) cannot be maintained, backwash is initiated.

When solids build up inside the Crossflow Filter tubes, differential pressure across the tube walls drop. At a differential pressure of 50 psig filter backwash is automatically initiated. Filter backwash is accomplished by closing H-261-OGB-FV-3700 and pressurizing the tank with Plant Air (H-261-PA-FV-3701 is opened), then the Backwash Valve (H-261-OGB-FV-3710) is opened and the Filtrate Flow Control Valve (H-261-OGB-FCV-3711) is closed reversing filtrate flow through the filter for a brief period of time. This "pulse" of filtrate dislodges the solid cake from the filter surface. Backwash from the filter flows to the Filter Feed Tank.

Currently DCS logic is being changed to also allow the operator to manually initiate backwash as necessary.

To manually initiate backwash the control room operator uses DCS Point Tag OGB3712PP. After a thirty (30) second delay the sequence of action is;

- H-261-OGB-SV-3711 closes and there is no more DCS control because the air was removed from the solenoid valve;
- H-261-OGB-SV-3700 fully closes because the solenoid valve de-energized;
- H-261-OGB-PV-3716 becomes fully open because there is no DCS control;
- ~ Ten (10) seconds later, H-261-OGB-SV-3701 becomes fully open;
- ~ Ten (10) seconds later, H-261-OGB-SV-3710 becomes fully open for ~ one second;
- ~ Five (5) seconds later, H-261-OGB-SV-3701 closes;
- ~ Five (5) seconds later, H-261-OGB-PV-3716 returns to DCS control; and
- ~ Ten (10) seconds later, H-261-OGB-SV-3711 is under DCS control and H-261-OGB-SV-3700 is fully open.

When high level or high slurry concentration is reached in the Filter Feed Tank, the contents of the tank are transferred to one of the Blowdown Hold Tanks by the Filter Concentrate Pump (H-261-OGB-P-3605).

Offgas Blowdown Flowpath

The filtration system does not remove salt or dissolved solids. When blowdown is initiated on high conductivity, the filtration system is bypassed and blowdown flow goes directly to the blowdown tanks. The DCS automatically initiates blowdown of the quench recirc tank when either density or conductivity signals are high

The Blowdown flowpath is shown on Figure 7, Offgas Blowdown. Blowdown waste is received by one of the two Blowdown Hold Tanks. Blowdown waste is received from the Filter Feed Tank or from the OGQ System blowdown that was initiated because of high conductivity/high salts (filtration will not concentrate salts).

The two Blowdown Hold Tanks are connected through cross-ties so that blowdown wastes can be either recirculated or transferred between tanks by either of two Blowdown Transfer pumps.

Caustic solution can be provided to adjust the pH to slightly basic >7, if necessary, to facilitate blowdown solidification. Typically, the pH of the blowdown solution is in the range of 7-9. The amount of caustic to be added will be determined by sampling.

The Blowdown System is equipped with Service Water connections for line and tank flushing as necessary. Sump liquids from the Ash-Out Sump are transferred to Blowdown Hold Tank No. 1 through a basket type duplex strainer.

A new modification to the Blowdown System has been added to allow processing of blowdown waste in the Ashcrete System. Discharge from the tank pumps is directed to the water addition station of the Ashcrete Processing Unit to allow the addition of 28 gallons of blowdown waste to be placed in each 55-gallon drum and subsequently immobilized in concrete. The blowcrete is then cured in the same manner as the ash. As of yet, the concerns the salt concentration in the blowdown waste and it's effects on immobilization and curing have not been resolved.

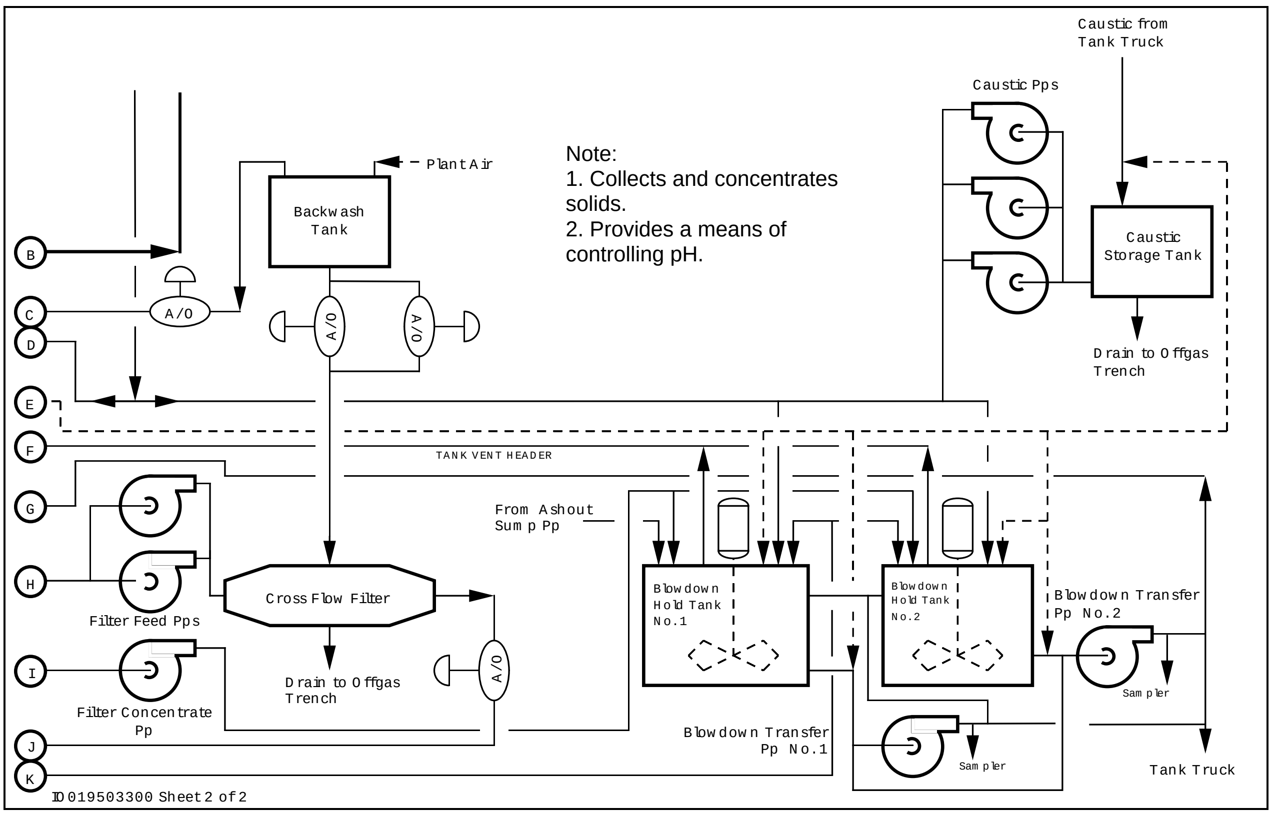


Figure 7 Offgas Blowdown Flowpath

Caustic System

ELO 1.02	**Briefly DESCRIBE how the OFFGAS System accomplishes it's intended purpose.**
ELO 3.03	**Given values for key performance indicators, DETERMINE if OFFGAS System components are functioning as expected.**

The Caustic System is shown on Figure 7, Offgas Blowdown and consists of a storage tank, three metering pumps, and associated piping and valves. Caustic is received into the Caustic Storage Tank from the Clean Unloading Area (Figure 8, Tank Farm Layout). 50 percent sodium hydroxide is diluted to 20 percent with Service Water added to the transfer line by a ratio controller. The Caustic System provides the means for controlling pH in various tanks in the Offgas System.

The sodium hydroxide (NaOH) solution is used for pH control in the Quench Recirculation Tanks, the Scrubber System and the Blowdown tanks.

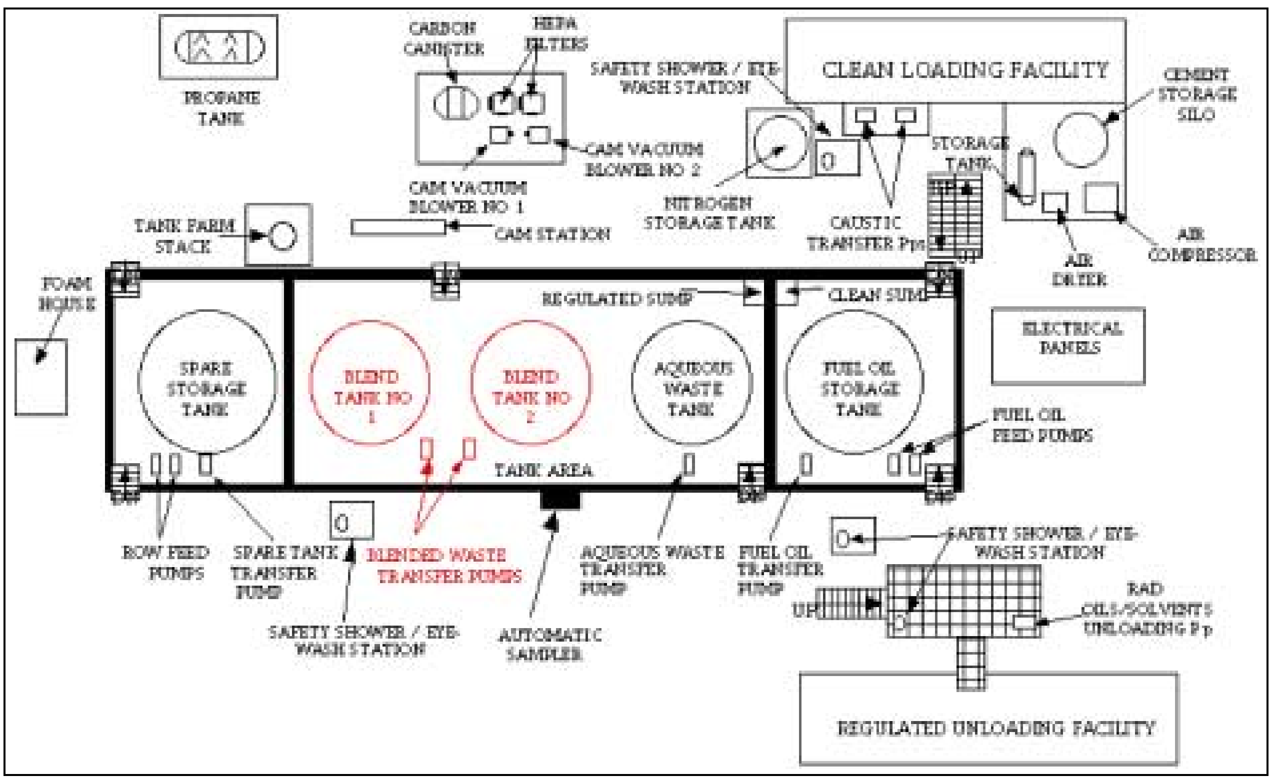


Figure 8, Tank Farm Layout

Summary

- The purpose of the Offgas System is to minimize the release of radionuclides and blowdown waste.
- The Offgas System primary flowpath consists of;

  Quench Vessel,

  Steam-jet Scrubber,

  Cyclone Separator,

  Mist Eliminator,

  Reheater,

  High Efficiency Particulate Air (HEPA) Filters,

  Induced Draft (ID) Fans,

  Stack.
- The Quench System is to reduce the temperature of the flue gas exiting the SCC, and remove paticulates.
- The Offgas from the Quench Separation Tank enters the Scrubber for removal of liquids with particulates, and liquids with absorbed acid gases and toxins..
- The Exhaust System maintains the flue gas at sub atmospheric pressure, filters radionuclides and heavy metals, and samples analyzes, and documents stack emissions.
- The Blowdown System is to minimize the volume of waste that must be disposed of by collecting and concentrating the solids removed from the flue gas.
- The Caustic System provides the means for controlling pH in various tanks in the Offgas System.

MAJOR COMPONENTS

ELO 2.01	**DESCRIBE the physical layout of the OFFGAS System components including, the general location, how many there are, and functional relationship for each of the following major components:** **a. Major Equipment** **b. Pumps** **c. Tanks** **d. Thermosyphons**
ELO 2.03	**Given a description of the OFFGAS System equipment status, IDENTIFY conditions which interfere with normal system flowpaths.**
ELO 2.04	**Given a description of abnormal equipment status for the OFFGAS System, EXPLAIN the significance of the condition on system operation.**

<u>OFFGAS QUENCH SUBSYSTEM (W830409 & W830316)</u>

ELO 3.01	**DESCRIBE the following major components of the OFFGAS System including their functions, principles of operation, and basic construction:** **a. Quench Vessel**
ELO 3.02	**STATE the design capacities and operational limitations for the following OFFGAS System major components:** **a. Quench Separation Tank** **b. Quench Recirculation Tank** **c. Quench Recirculation Pumps**

Quench Vessel (H-261-OGQ-VSL-4006)

The Quench Vessel (Figure 9 Offgas Quench) provides cooling of the Offgas. The Quench Unit is designed for 12 psig and 35 inches of WC vacuum at 2012 °F. The upper section of the Quench Vessel is conical and contains spray rings for the first and the second quench header. Both of the headers use a flow of 80-85 gpm at a minimum of 30 psig, and are normally fed from the Quench Recirc. pumps. The 1st quench header can also be fed with emergency quench water from either the Emergency Service Water or Emergency Fire Water systems. The Scrubber Recirc. pumps supply makeup water through a 3-way valve to the 1st header.

The 2nd quench header, provides a tangential spray for cooling the vessel walls and carbon brick lining. This prevents the buildup of solids and the formation of a wet-dry interface.

The conical upper section of the vessel joins a cylindrical throat section that incorporates three additional rows of sprays, Rows 3, 4 and 5. Rows 3 & 4 provide 80 gpm of quench liquid at a minimum of 30 psig and row 5 provides 120 gpm at a minimum of 30 psig. Row 4 is provided solely for emergency quench purposes. This fourth row is equipped with an air purge to ensure that the header and sprays remain clear.

The spray nozzles generate a relatively coarse spray (approximately 2500 micron diameter droplets), minimizing the fine particulate that could occur in the high temperature upper section of the Quench Vessel. The smaller the water droplet, the more readily it will evaporate leaving behind airborne particulates.

The cylindrical throat section is designed to provide turbulent mixing of the downcoming gas and the recirculation liquid. The turbulence and high gas velocity relative to the spray droplets breaks up the droplets to approximately 250 micron average diameter. A high liquid to gas ratio provides a large surface area for heat transfer and minimizes the formation of solids.

The conical section is constructed of Hastelloy™ C22 with 9" thick, 90% alumina brick refractory and a 1" thick wool, insulating blanket. The cylindrical section is constructed of carbon steel with a 90 mil Halar lining under a 4.5" thick carbon brick refractory.

OGQ Separation Tank (H-261-OGQ-TK-002)

The Quench Separation Tank (Figure 9) provides a single-stage, gravity separation of quench liquid from the cooled gas. The Quench Separation Tank drains, through a conical drain, through a six-inch line to the Quench Recirc. Tank. A six-inch overflow is also provided for the unlikely event of bottom drain pluggage. The overflow connects with the drain line downstream of the bottom drain. Normally, the Separation Tank has only a minimal level. The tank is provided with a level gauge and an associated alarm to detect a liquid level buildup and alert the operator.

The separation tank is fabricated of carbon steel plate and is lined with a 90 mil thick Halar lining. The tank contains 10 nozzles which connect to vents from the Quench Recirculation Tank, Ashout Tank, Ram Feed housings, and associated instrumentation. A 24" access door is provided to allow entry for inspection of the Halar and refractory linings in the Quench vessel. The door is made of milled steel and is lined with a 10 mil thick layer of Halar lining.

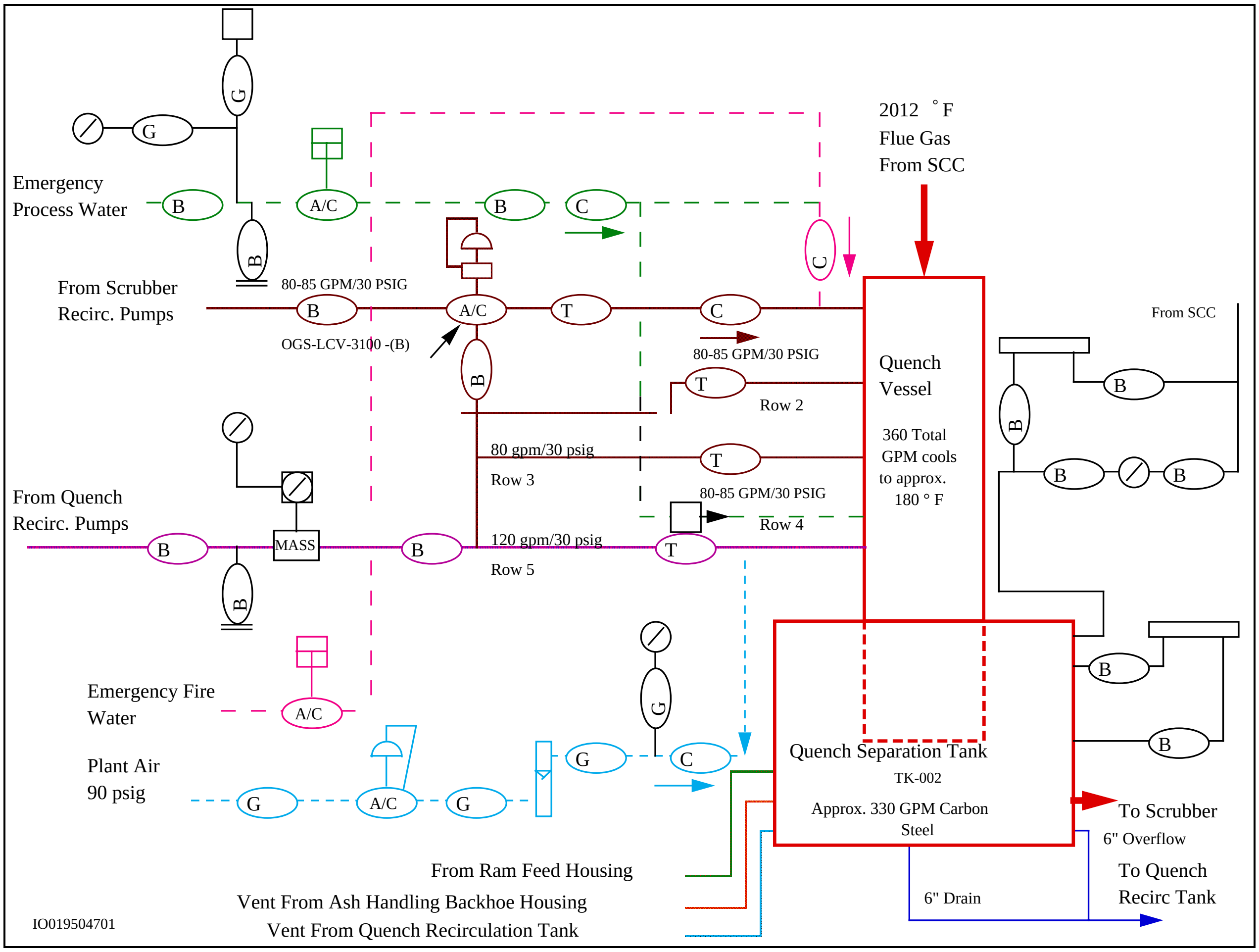


Figure 9 Offgas Quench

OGQ Recirc Tank (H-261-OGQ-TK-001)

The OGQ Recirc Tank (Figure 10 Offgas Quench Recirc) provides surge capacity for Quench System operation collecting liquid from the Quench Separation Tank for recirculation. It has a capacity of 6000 gallons with a normal working volume of 4500 gallons.(70 inches) With the normal recirculation flow to the Quench Vessel consisting of approximately 330 gpm (the other approximately 30 gpm is makeup from the Scrubber Recirculation System) this provides a surge volume of just under 14 minutes.

The Tank is 10 feet in diameter and 10 feet tall and rests on a 1/2 inch neoprene pad. The tank is equipped with a vacuum breaker and overflow piping. Overflow is piped to the Offgas Trench through a loop seal.

The Quench Recirc Tank design pressure is 4.33 psig and 6” WC vacuum at 180°F. It is constructed of Derakane® 470-36 Fiberglass Reinforced Plastic (FRP) with Ultraviolet (UV) protection (UV-9) in the outer layer. The reinforcement construction of the tank is nexus veil and 3MAT (type of layer) with 24 ounce woven roving (layering). A minimum of 6” of liquid must be maintained in the tank at all timed to prevent damage to the tank bottom when under vacuum conditions. The pump suction nozzle is oriented with an extension piece which terminates 6" above the tank bottom to ensure that a minimum level remains in the tank to prevent pump cavitation. The tank top is reinforced by four stiffeners made from 6" piping cut in half and encapsulated in the resin. The tank is also equipped with a top-mounted agitator to keep undissolved solids in suspension. MCC 5 powers the agitator.

OGQ Recirc Pumps (H-261-OGQ-P-3103-A&B)

The two Recirc Pumps (Figure 10) are 100% capacity, centrifugal pumps, each rated for approximately 390 gpm at 173 ft TDH. Operating range is 300-330 gpm. The pumps are equipped with double mechanical seals and a forced circulation barrier fluid system (Thermosyphon). The pumps are driven by 40 hp motors powered from MCC 7 (Recirculation Pump, No. 1, P-3103-A) and MCC 8 (Recirculation Pump, No. 2, P-3103-B).

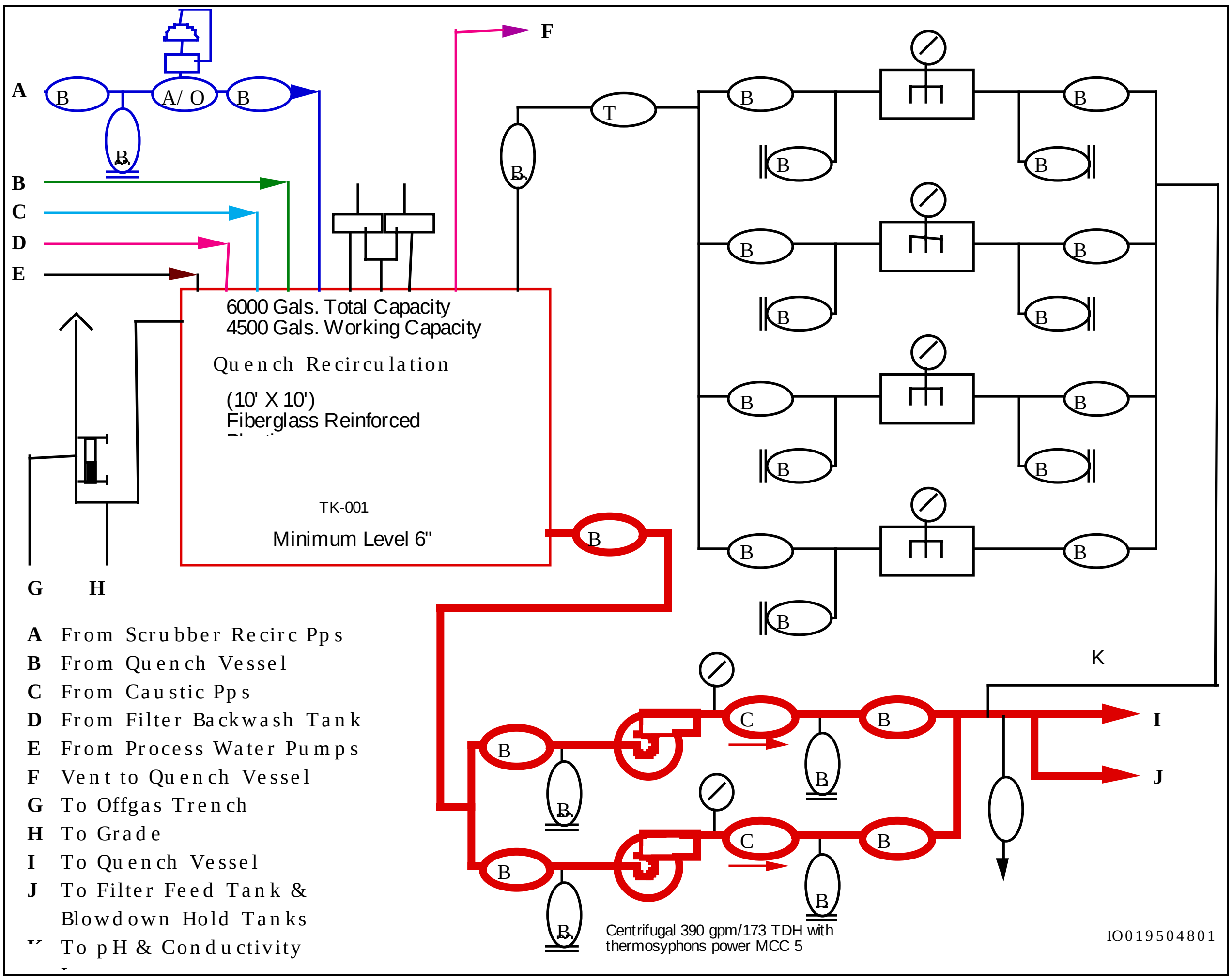


Figure 10 Offgas Quench Recirc

OFFGAS SCRUBBER SYSTEM (W830315, W830317, & W830318)

ELO 3.01	**DESCRIBE the following major components of the OFFGAS System including their functions, principles of operation, and basic construction:** **b. Steam-Hydro Scrubber** **c. Cyclone Separator** **c. Mist Eliminator**
ELO 3.02	**STATE the design capacities and operational limitations for the following OFFGAS System major components:** **d. Scrubber Recirculation Tank** **e. Scrubber Recirculation Pumps**

Offgas Scrubber (H-261-OGS-SF-001)

The scrubber (Figure 11 Offgas Scrubber) is a HydroSonic Model 1000 System that incorporates a steam eductor to generate a high velocity mixing of scrubber solution with Offgas. Scrubbing liquid and caustic soda are introduced at the eductor throat where a sonic wave is developed, breaking up the scrubbing liquid into fine drops which capture particulates down to the sub-micron range and absorb/neutralize acidic gases. The liquid droplets coalesce in a mixing tube into larger droplets that are removed in the downstream Cyclone Separator. The steam (300 psig) flow rate to the scrubber is maintained in the range of 6500 to 20,000 pounds per hour, dependent upon plant operating mode, waste and fuel flows and temperatures. Scrub liquid is injected, through sprays, into the scrubber at a range of 56-74 gallons per minute.

The scrubber housing is made of Hastelloy C-22 plate. The housing contains the steam ejector nozzle and water ring which provide the mixture which is broken into fine droplets to scrub the offgas stream. The ejector and water ring are made of Hastelloy C-22 material also. The water ring contains six spray nozzles which direct the scrub solution into the offgas stream.

A twenty percent caustic solution is provided to the scrub solution through a mixing tee upstream of the scrubber liquid inlet at an design average flow of 5 gallons per hour.

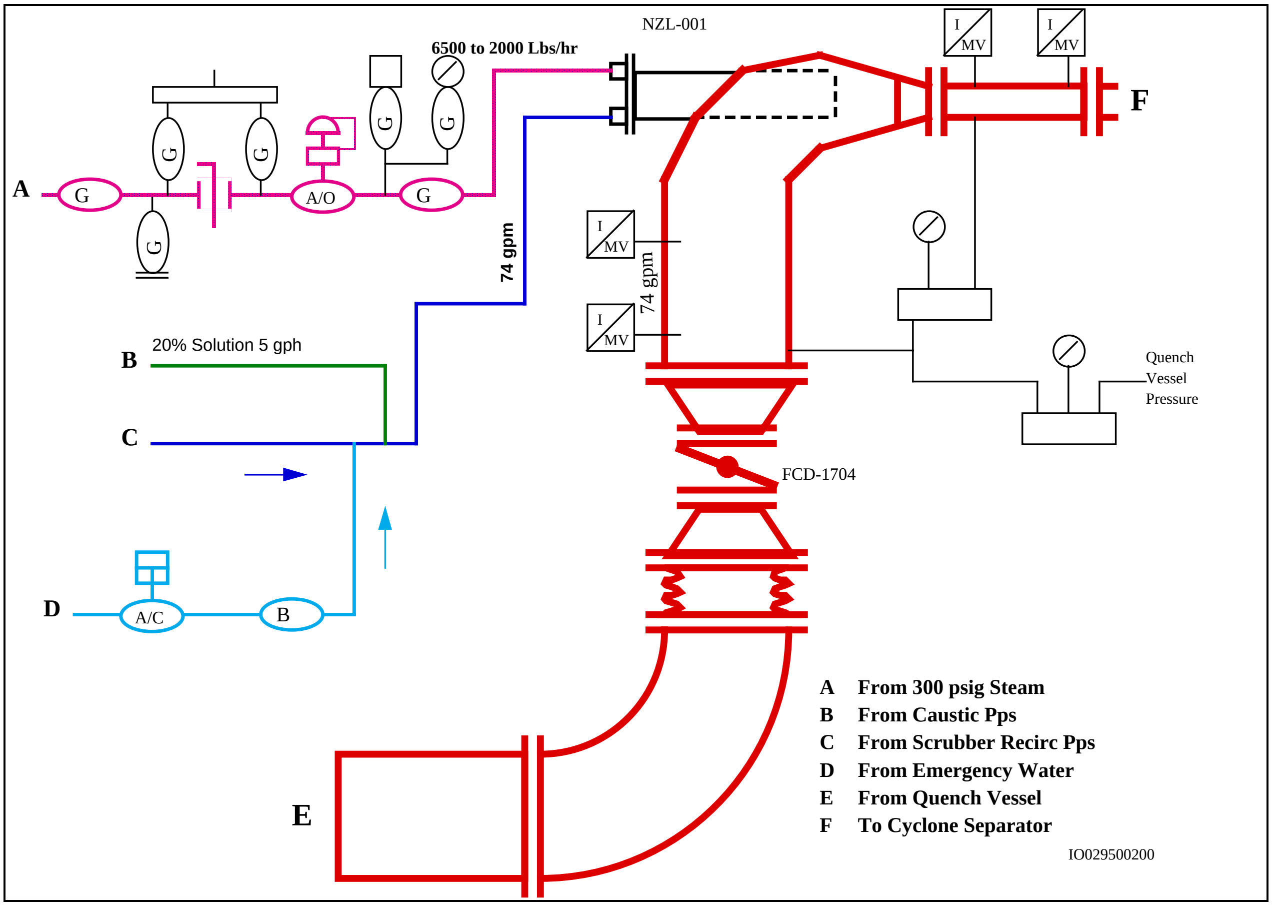


Figure 11 Offgas Scrubber

Cyclone Separator (H-261-OGS-SEP-001)

The Cyclone Separator (Figure 12 Cyclone Separator and Mist Eliminator) is integrated with the scrubber by it's connection to the mixing tube. It removes liquid and particulates from the gas stream by forcing the stream to change directions. The inertia of the liquid molecules and the particulates makes it difficult for them to change directions and results in them impacting against the baffles and draining down and out of the separator to the Scrubber Recirculation Tank.

The separator is a fiberglass reinforced plastic vessel. It is designed for a pressure of 5 psig and a vacuum of -35" WC at 250°F. A 10% abrasive resistant filler is added to the vessel lining to resist the abrasive effects of the offgas particulate. The inlet nozzle is reinforced for added strength and is offset to the side of the separator. A Hastelloy impingement plate protects the wall at the vessel inlet from erosion by offgas particulates. Offgas enters the vessel through the offset inlet and whirls around the inside releasing the entrained moisture and particulates by centrifugal force. A 46" diameter duct extends 105" into the vessel which forces the offgas down into the separator before it may exit. The offgas exits the Cyclone Separator through the 46" duct to the Mist Eliminator.

Mist Eliminator (H-261-OGS-VAPX-001)

The Mist Eliminator (Figure 12) consists of two separation modules in series. The first module is a Kynar mesh pad with a sinusoidal (wavy) vane baffle. The second module is a sinusoidal vane baffle. The mechanisms for mist and particulate removal are coalescence in the mesh pad and impingement upon the vanes as the gas change's direction.

The Mist Eliminator is designed for 100 percent removal of entrained liquid droplets greater than 10 microns, and 97 percent removal of droplets greater than 5 microns. The Mist Eliminator provides a backup for the Cyclone Separator where the maximum carryover size is approximately 6 microns.

Each of the two modules have provisions for washing by internal sprays. The wash drains by gravity to the scrubber recirculation tank replacing makeup water. There are two spray headers, each with two sprays, upstream of the mesh pad. Each of these two headers is designed for 10 gpm at 30 psi. There are also two headers, each with four sprays, between the two modules. Two of the four sprays are directed upstream, the other two are directed downstream. Each of these two headers is designed for 20 gpm at 30 psi.

All sprays can be operated periodically to wash down the modules. One of the 10 gpm sprays can be left on for continuous cleaning of the mesh pad. At 10 gpm, the flow is less than half of the average makeup to the scrubber system and will not adversely effect the Service Water makeup control. The wash on the spray pad condenses some vapor in the gas stream and this mechanism in conjunction with the wetted surface is expected to assist in the removal of mist and particulates.

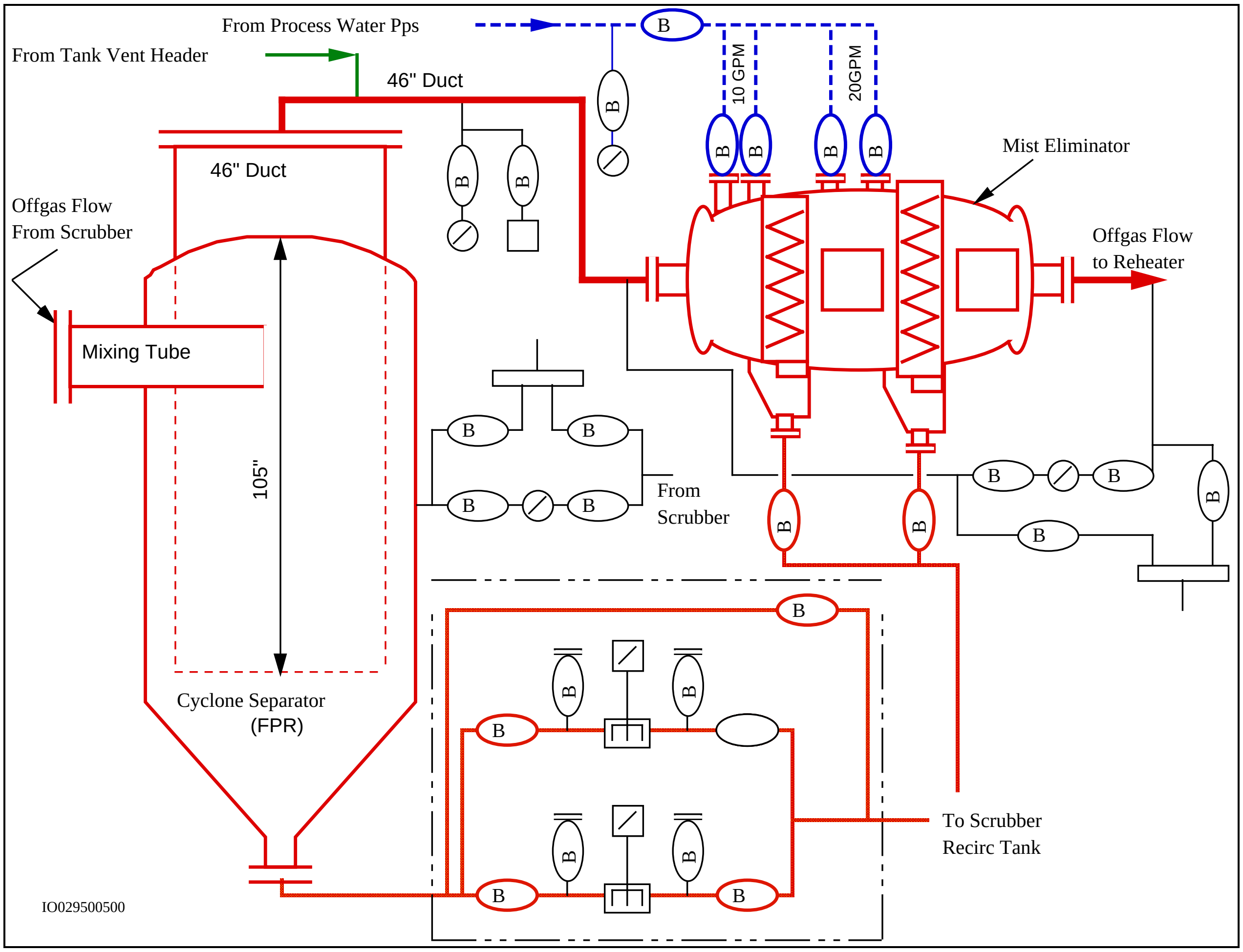


Figure 12 Cyclone Separator and Mist Eliminator

OGS Recirculation Tank (H-261-OGS-TK-001)

The Scrubber Recirculation Tank (Figure 13 Offgas Scrubber Recirc) collects liquid draining from the Cyclone Separator and Mist Eliminator, makeup water from the plant water system, and maintains solids in suspension. The tank is constructed of Fiberglass Reinforced Plastic and is approximately 8 feet in diameter and 10 feet high with a flat top and bottom. The design pressure and temperature for the tank is 4.33 psig and 6" WC vacuum at 180°F. The tank is made of materials similar to those used in the Quench Recirculation Tank. The tank vents to the Cyclone Separator.

The tank has a capacity of 3800 gallons with a working volume of 2550 gallons (70") and a recirculation plus quench make-up flow of 60 - 75 gpm providing approximately 40 minutes surge capacity. The OGS Recirc Tank is equipped with a top-mounted agitator powered from MCC 5 to keep solids in suspension.

OGS Recirc Pumps (H-261-OGS-P-3304 A&B)

There are two 100% capacity pumps. The pumps (Figure 13) are centrifugal pumps, each rated for approximately 126 gpm at 222 ft TDH. The operating range is 31-69 gpm. The pumps are equipped with double mechanical seals and a forced circulation barrier fluid system (Thermosyphon). The pumps are driven by 20 hp motors powered from MCC 7 (Scrubber Recirculation Pump No. 1, H-261-OGS-P-3304-B) and MCC 8 (Scrubber Recirculation Pump No. 1, H-261-OGS-P-3304-A)

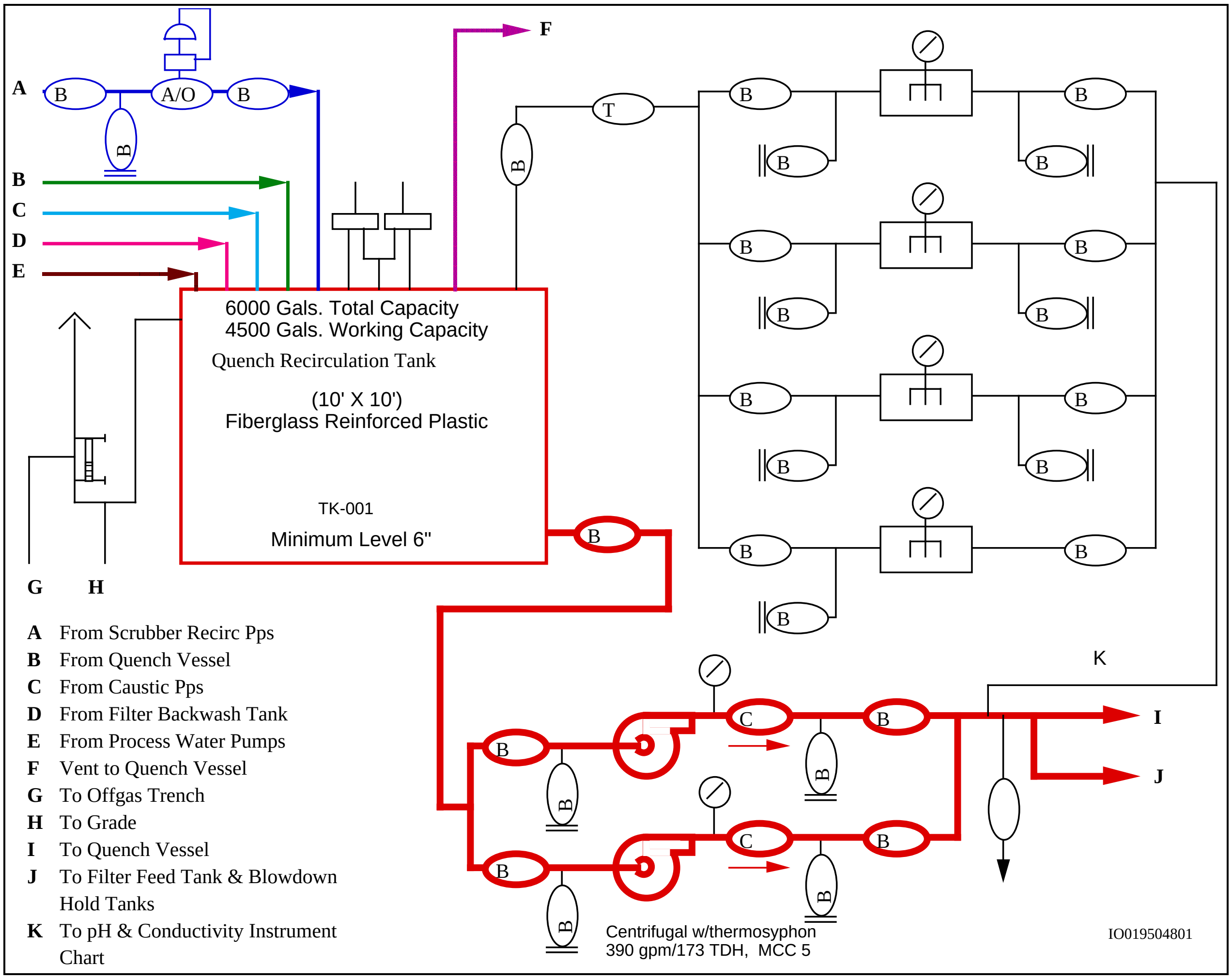


Figure 13 Offgas Scrubber Recirc

OFFGAS EXHAUST SYSTEM (W830319 & 830320)

ELO 3.01	**DESCRIBE the following major components of the OFFGAS System including their functions, principles of operation, and basic construction:** **e. Reheater** **f. HEPA Filters** **g. Induced Draft Fans** **h. Stack Monitoring**
ELO 3.02	**STATE the design capacities and operational limitations for the following OFFGAS System major components:** **f. Damper**

Reheater (H-261-OGE-RHTR-001)

The Reheater (Figure 14 Offgas Reheater and HEPA Filters) heats the offgas to minimize condensation and ensure optimum HEPA filter efficiency and is designed for 1.03 x 106 BTU/HR load. The shell is designed for 300 °F at -20 inches WC. The steam coils are designed for a pressure and temperature of 200 psig and 400 °F. The heating coils are made of stainless steel. Each of the coils can be isolated and removed. A blank-off plate is provided to seal the casing when a coil section is removed

HEPA Filters (H-261-OGE-FLT-001; 002; & 003)

Each of the banks (Figure 14) contains nine 2-feet by 2-feet filter, prefilter and HEPA filter elements each with a dust loading capacity up to 4 pounds per HEPA filter (total dustload capacity for 2 banks = 36 lbs. x 2 = 72 lbs). Each filter housing is designed for 10,645 ACFM at 250 °F and 30-inches WC. Filter change-out is based on pressure differential (5 psid).

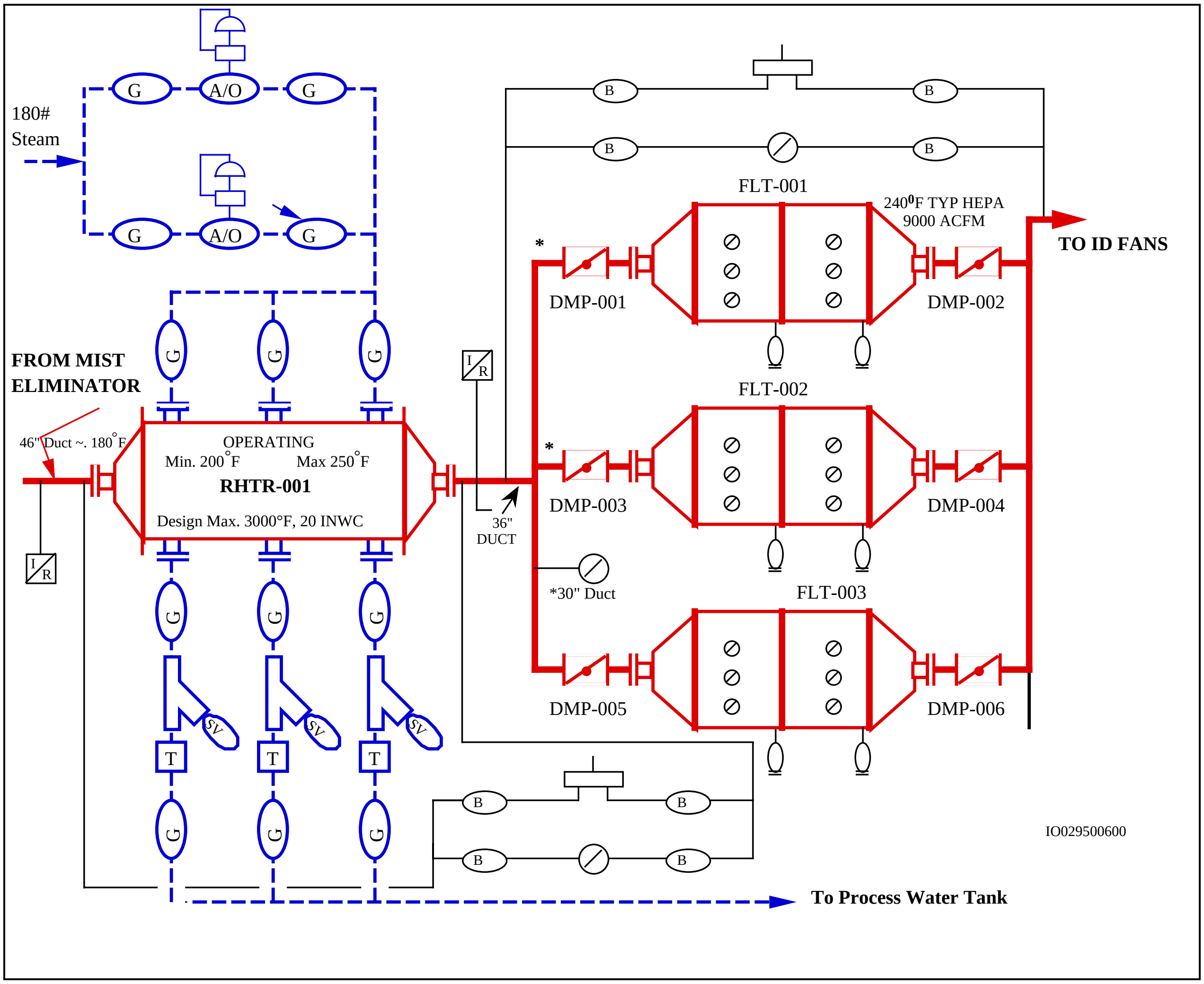


Figure 14 Offgas Reheater and HEPA Filters

ID Fans (H-261-OGE-FAN-3505; 3506; & 3513)

Each ID Fan (Figure 15 Offgas ID Fans and Stack) is rated at 12,000 ACFM at 26 inches WC pressure differential. Based on fan control and system operating curves, a single fan can operate over a range of 6000 to 17,000 ACFM and two fans can operate over a range of 12,000 to 24,000 ACFM total flow. This configuration provides an overlap of 5000 ACFM.

The ID Fans are powered from the standby power buses (supplied by standby diesel generators). ID Fans 3505 (H-261-OGE-FAN-3505) and 3506 (H-261-OGE-FAN-3506) are powered from MCC 7, Fan 3513 (H-261-OGE-FAN-3513) is powered from MCC 8.

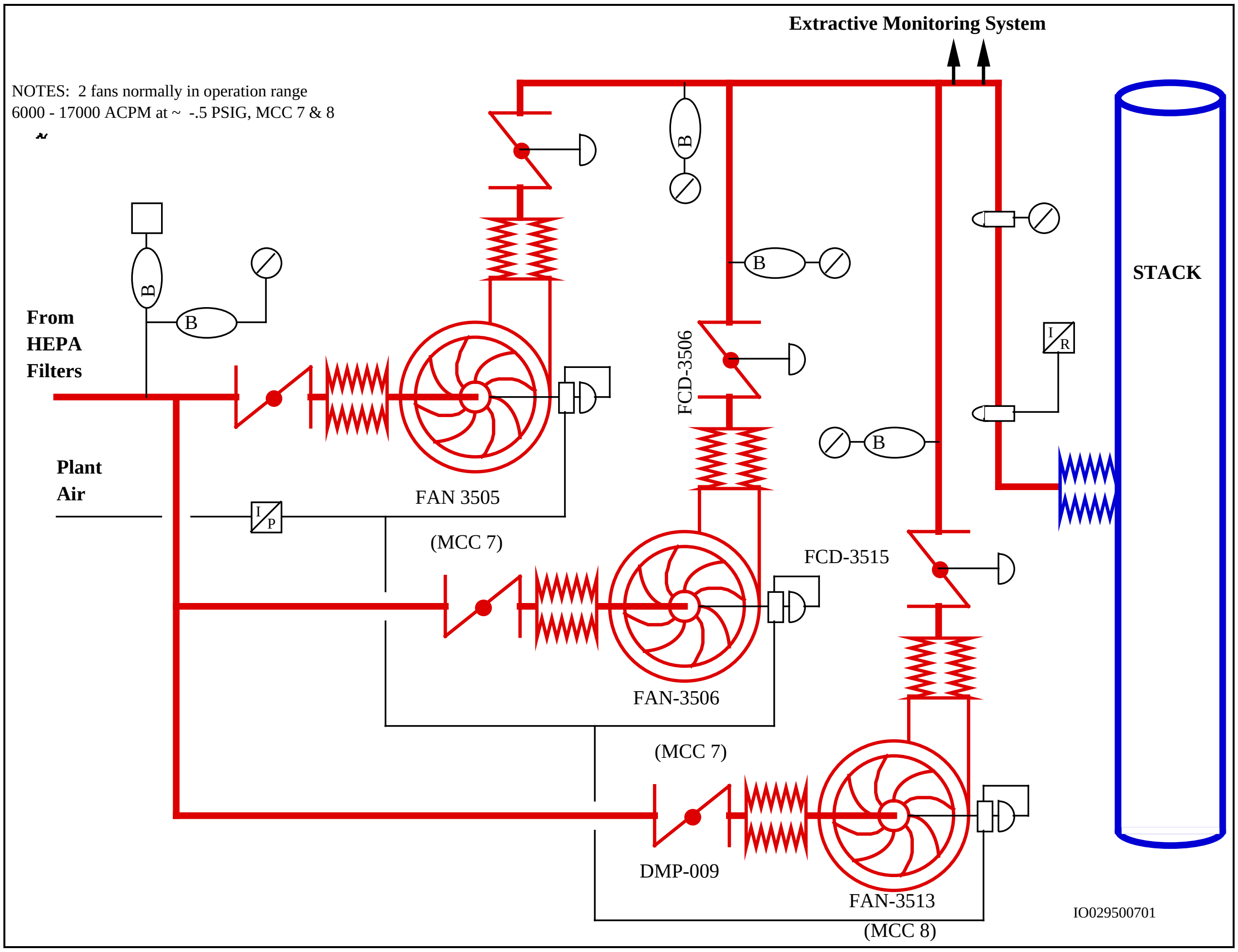


Figure 15 Offgas ID Fans and Stack

OFFGAS BLOWDOWN (W830321, W830322, W830323, & W830409)

ELO 3.02	**STATE the design capacities and operational limitations for the following OFFGAS System major components:** **g. Filter Feed Tank** **h. Filter feed Pumps** **i. Transfer Pump** **j. Blowdown Tanks 1 & 2.** **k. Blowdown Transfer Pumps 1 & 2**

Filter Feed Tank (H-261-OGB-TK-003)

The Filter Feed Tank (Figure 17 Filter Feed) is 8-feet in diameter and 10-feet tall with a flat bottom and top has a capacity of 3800 gallons and a working volume of 2250 gallons. The tank provides a surge capacity of 27 hours based on design usage of 83 gph.

The design pressure for the tank is 4.33 psig and 6”WC vacuum at 180°F. Pressure protection is provided by a vacuum breaker and overflow piping. The tank is constructed of FRP with a UV protection additive.

The Filter Feed Pumps suction is located approximately two feet above the tank bottom while the Filter Concentrate Pump suction is located approximately 6 inches above the tank bottom. This arrangement avoids the recirculation of heavy solids, in addition, the location of the Concentrate Pump suction ensures a minimum level in the tank which, in turn, provides protection for the non re-enforced tank bottom when operating under vacuum.

The Filter Feed Tank is equipped with a top-mounted agitator that is driven by a 1 hp motor powered from MCC 5.

Filter Feed Pumps (H-261-OGB-P-3615 A&B)

The Filter Feed Pumps (Figure 17) are centrifugal pumps with FRP casings and are designed to pump 300 gpm at 185 feet TDH. The pumps are equipped with double mechanical seals and a forced circulation barrier fluid system (Thermosyphon). The Filter Feed Pumps are driven by 30 hp motors powered from MCC 5

Filter Concentrate Pump (H-261-OGB-P-3605)

The Filter Concentrate Pump (Figure 17) is a centrifugal pump with an FRP casing and is designed to pump 75 gpm at 60 feet TDH. The pump is equipped with double mechanical seals and a forced circulation barrier fluid system (Thermosyphon). The Filter Concentrate Pump is driven by a 20 hp motor powered from MCC 5.

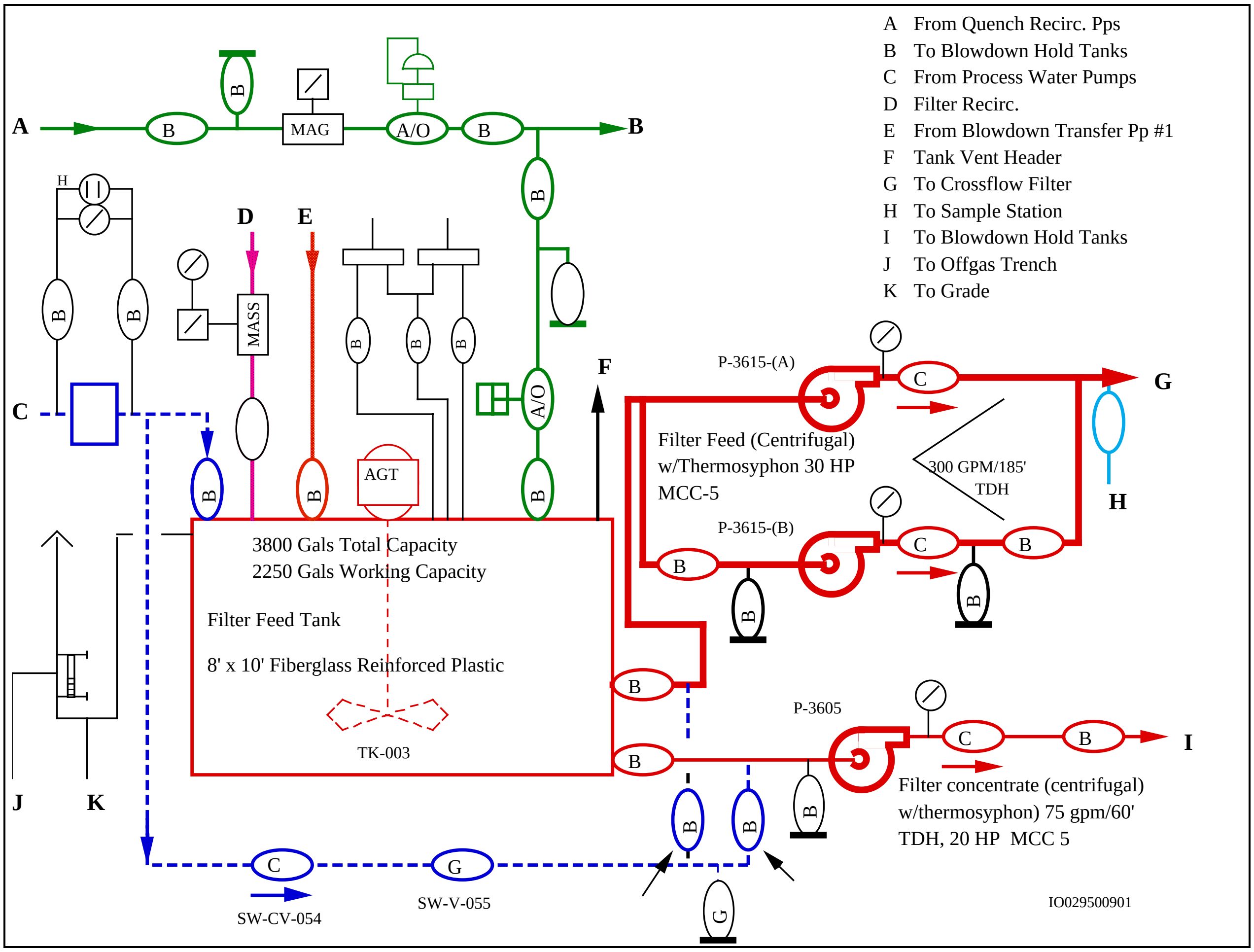


Figure 16 Filter Feed

ELO 3.01	**DESCRIBE the following major components of the OFFGAS System including their functions, principles of operation, and basic construction:** **i. Crossflow Filter**

Crossflow Filter (H-261-OGB-FLT-001)

The filter (Figure 16 Offgas Crossflow Filter) is operated in batch mode but when in operation will be run continuously to prevent solids from hardening on the filter surface. The Crossflow Filter is designed for high velocity flow of the slurry liquid at a right angle to the filter surface. The crossflow sweeps away the bulk of the solids cake as it forms on the filter surface. A thin film of the solids remains on the filter surface acting as a prefilter.

The bulk slurry flow is 300 gpm flowing through 31 5/8-inch inside diameter by 120-inch long sintered metal tubes. The filtrate flows through the sintered metal tube wall into the slurry filter shell and is returned to the Quench Recirc Tank at a rate controlled by the Filtrate Flow Control Valve

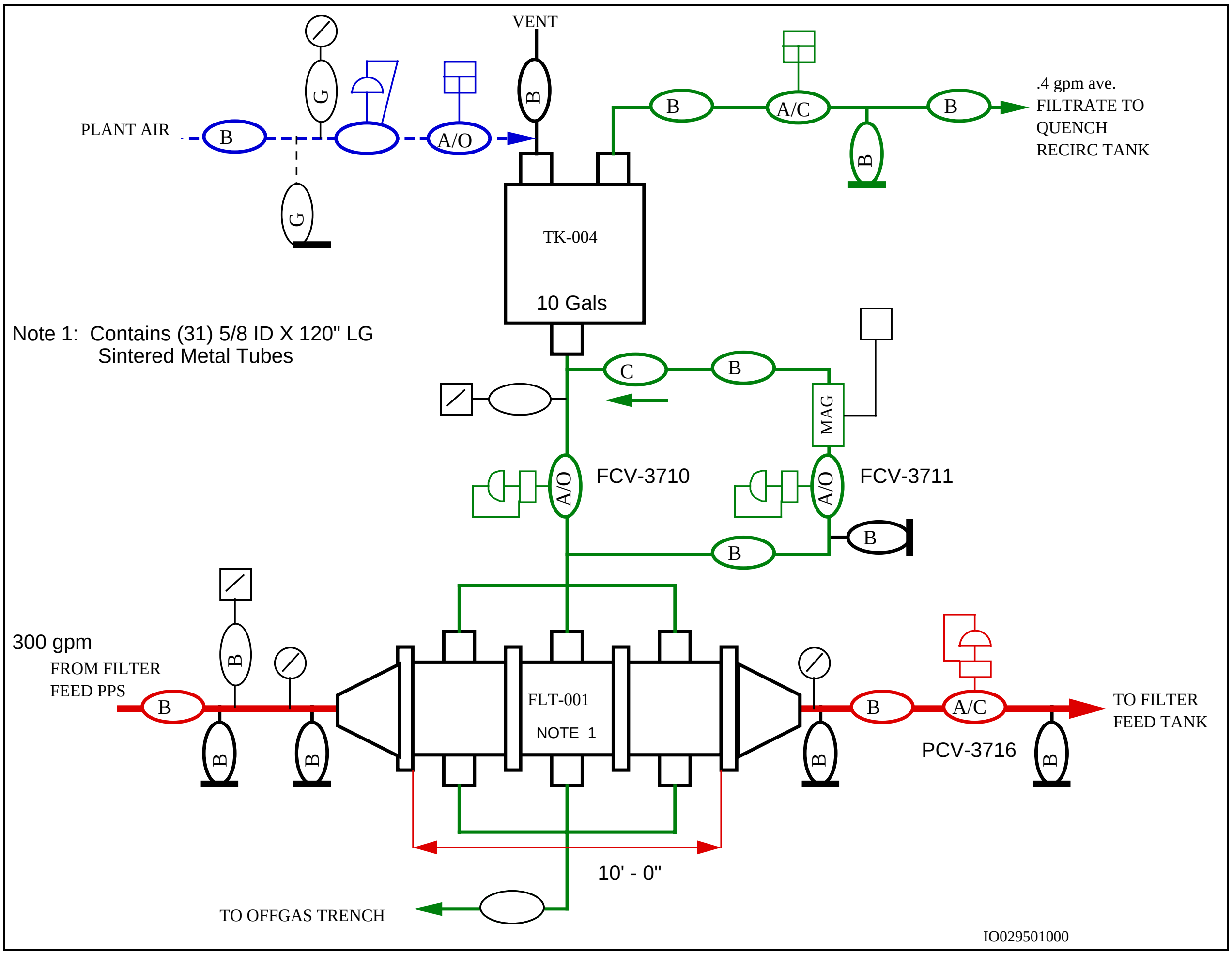


Figure 17 Offgas Crossflow Filter

Blowdown Hold Tanks (H-261-OGB-TK-001 & 002)

The Blowdown Hold Tanks (Figure 18 Offgas Blowdown) are identical 6000 gallon tanks with a working volume of 5000 gallons that provides about 7 days' storage at average design rate. They are constructed of FRP. They are 10-feet in diameter and 10-feet tall with flat bottoms and tops. The tanks, except for the tank bottoms, are designed for 4.33 psig and 6”WC at 180°F.

To protect the flat bottoms, the suction for the transfer pumps is 6-inches above the bottom of the tank just as that described for the Filter Feed Tank and the Filter Concentrate Pump. Additional protection for the tanks is provided by vacuum breaker vents and loop seal overflow systems. The tanks are equipped with top-mounted agitators that are driven by 1 hp motors powered from MCC 5.

Blowdown Transfer Pumps (H-261-OGB-P-3803 & 4104)

The Blowdown Transfer Pumps (Figure 18) are centrifugal pumps with FRP cases. The pumps are equipped with double mechanical seals and a forced circulation barrier fluid system (Thermosyphon). The pumps are rated at 75 gpm at 75 ft TDH and are driven by 5 hp motors powered from MCC 5

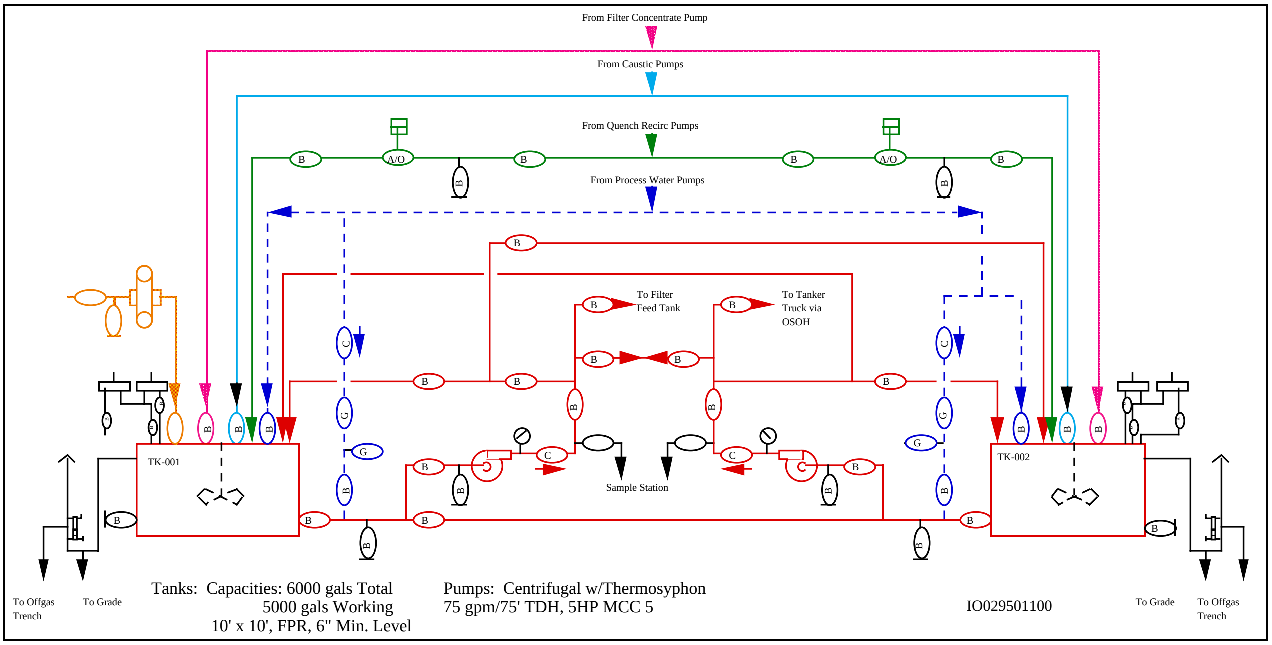


Figure 18 Offgas Blowdown

CAUSTIC SYSTEM (W830325)

ELO 3.02	**STATE the design capacities and operational limitations for the following OFFGAS System major components:** **j. Caustic Metering Transfer Pumps** **k. Caustic Storage Tank** **i. Caustic Unloading Pump**

Caustic Metering Transfer Pumps (H-261-CAUS-P-3104; 3208; & 3904)

The three Caustic Pumps (Figure 19 Caustic System) are Milton Roy HPD (High Performance Diaphragm) Metallic Liquid End Metering pumps. They are 1 hp, variable speed, variable stroke, positive displacement pumps that provide flow up to 160 gallons per hour at 125 ft. TDH. The Caustic Pumps have DC drive motors powered from a variable speed drive. The variable speed drives are powered by transformers 3904, 3208 and 3104 powered from MCC's 7 & 8. H-261-CAUS-P3904 is powered from MCC 7.

Caustic Storage Tank (H-261-CAUS-TK-001)

The Caustic Storage Tank (Figure 19) is a 6000 gallon tank, welded carbon steel vessel with a diameter of 10 feet and a height of 10 ft. The working volume of the tank is 5500 gallons that provides a 12 day supply of caustic based on a process use rate of 19 gallons per hour. Tank pressure protection is provided by a vent to atmosphere and an overflow that drains to the Offgas Trench.

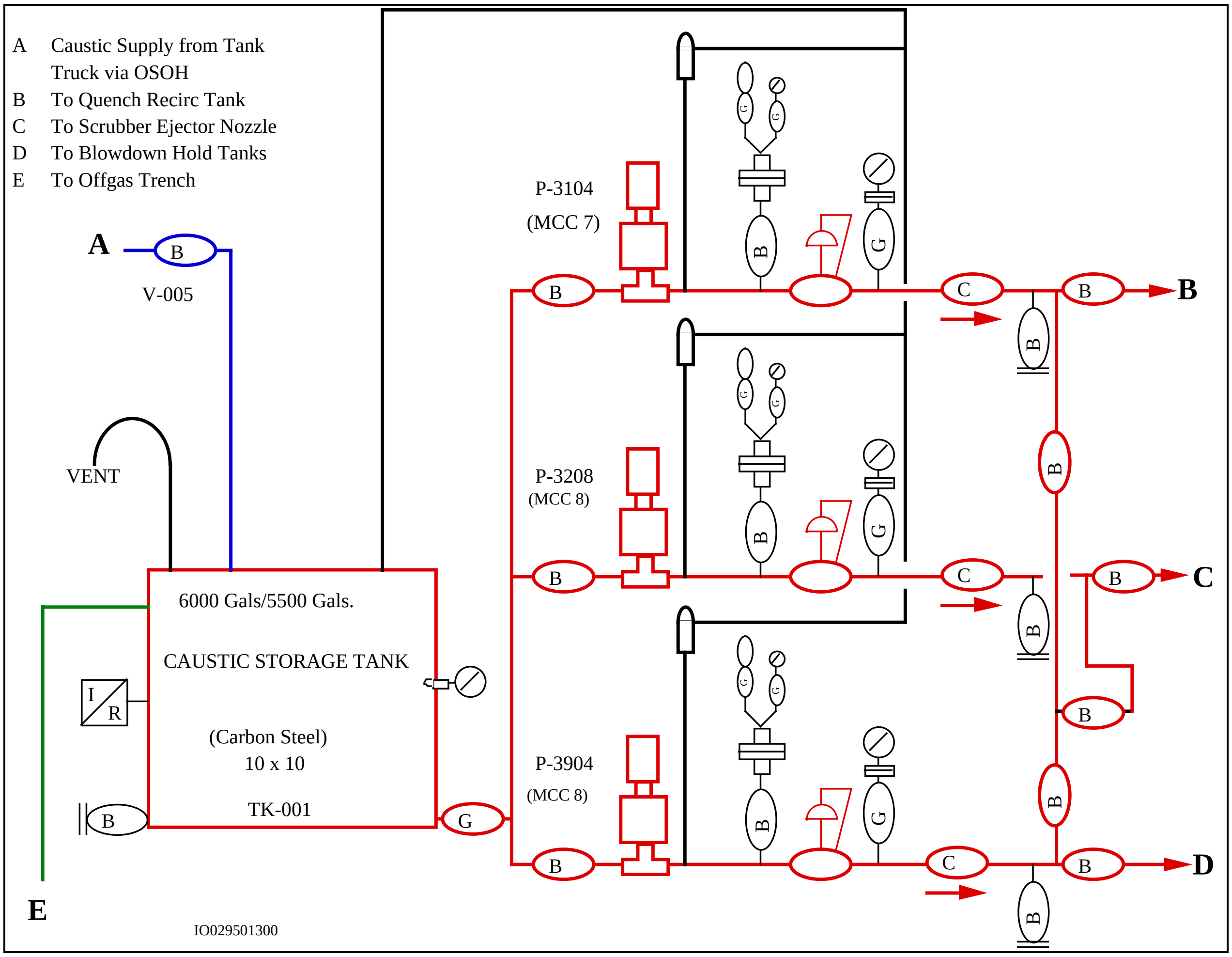


Figure 19 Caustic System

Caustic Unloading Pump (H-262-CAUS-P-0053)

The caustic unloading pump is horizontal, centrifugal pumps. It provides 50 gpm at 92 ft TDH with an explosion proof 5 HP motor. The shell is cast iron. At operating rate it takes about two hours to unload a delivery vehicle. See Figure 20

ELO 2.01	**DESCRIBE the physical layout of the OFFGAS System components including, the general location, how many there are, and functional relationship for each of the following major components:** **a. Major Equipment** **b. Pumps** **c. Tanks** **d. Thermosyphons**

Thermosyphons

Thermosyphons are used on the Offgas System Quench Recirc, Scrubber Recirc, Filter Feed and Concentrate, Blowdown, and Caustic Unloading pumps. The thermosyphons are a type of seal cooling system used on mechanical seals when normal cooling leakage cannot be used. Normal cooling of mechanical seals is provided by a design leakage along the pump shaft of the fluid being pumped, however, when pumping hazardous or contaminated fluids, leakage is not permissible.

The thermosyphons in the Offgas System at CIF use a fluid mixture of 50% water and 50% ethyl glycol (antifreeze). The water/glycol mixture is stored in a reservoir located above the pump. Natural circulation of the cooling fluid is accomplished by using the temperature differences and the resultant density differences between the cooling fluid in the pump and the fluid in the reservoir. The reservoirs are pressurized with plant air to ensure that flow is directed to the pump seals.

The tanks, pumps, and thermosyphons associated with the Offgas System are on Figure 21, Offgas System Tanks. Transfers between tanks are also shown on Figure 21.

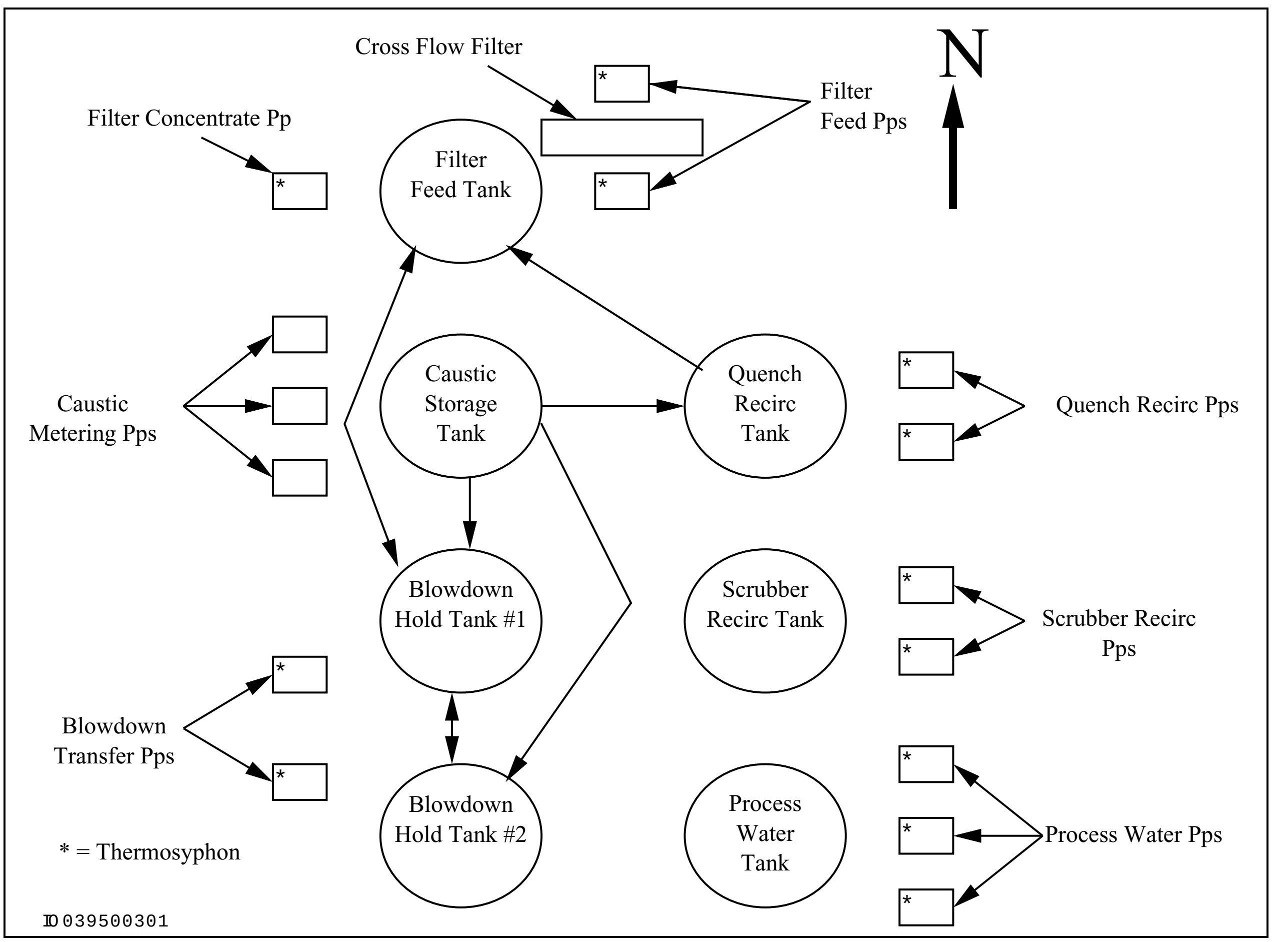


Figure 21 - Offgas System Tanks

Summary

- The Quench Vessel provides cooling of the flue gas. The Quench Separation Tank provides a gravity separation of quench liquid from the cooled gas.
- The scrubber captures sub-micron particulates, and absorbs and neutralizes acidic gases. The Cyclone Separator removes liquid and particulates from the gas stream by forcing the stream to change directions. The Mist Eliminator provides a backup for the Cyclone Separator by removing 97% of the liquid droplets greater than 6 micron size.
- The Reheater heats the offgas to ensure optimum HEPA filter efficiency. The three HEPA filters primarily remove radionuclides and heavy metals. Each ID Fan is capable of maintaining the offgas system at sub atmosphere pressure. The integral dampers are used to control system pressure.
- The filter feed tank, pumps, and crossflow filter operate to reduce undissolved solids in the Offags Quench system. The two Blowdown Hold Tanks are connected through cross-ties so that blowdown wastes can be either recirculated, transferred between the tanks or sent to the ashcrete processing unit. by either one of the two Blowdown Transfer pumps.
- Thermosyphons are a passive pump sealing device designed to contain hazardous liquid leakage.
- The three caustic pumps are positive displacement pumps with the stroke adjusted by the field operator.
- See Table 3 Offgas Tank Comparisons
- See Table 4 Offgas Pump Comparisons

OFFGAS TANK COMPARISON

Tank Noun Name	CLI #	Dimensions Diameter x Height	Material	Capacity Total/Working	Limits	Min level	Agitator Powered From
QUENCH RECIRC TANK	H-261-OGQ-TK-001	10 X 10	Fiberglass Re-inforced Plastic	6000 Gals/4500 Gals (70")	4.33 psig 6 INWC at 180 deg.F	6"	MCC 5 MCC 5
SCRUBBER RECIRC	H-261-OGS-TK-001	8 x 10	Fiberglass Re-inforced Plastic	3800 Gals/2550 Gals	4.33 psig 6 INWC at 180 deg.F	6"	MCC 5 MCC 5
FILTER FEED	H-261-OGE-TK-001	8 x 10	Fiberglass Re-inforced Plastic	3800 Gals/2550 Gals	4.33 psig 6 INWC at 180 deg.F	6"	MCC 5 MCC 5
BLOWDOWN HOLD # 1	H-261-OGB-TK-001	10 X 10	Fiberglass Re-inforced Plastic	6000/5000	4.33 psig 6 INWC at 180 deg.F	6"	MCC 5 MCC 5
BLOWDOWN HOLD # 2	H-261-OGB-TK-002	10 X 10	Fiberglass Re-inforced Plastic	6000/5000	4.33 psig 6 INWC at 180 deg.F	6"	MCC 5 MCC 5
CAUSTIC STORAGE	H-261-CAUS-TK-001	10 X 10	Carbon Steel	6000/5000	4.33 psig 6 INWC at 180 deg.F	6"	MCC 5 MCC 5

Table 3 Offgas Tank Comparisons

OFFGAS PUMP COMPARISONS

Pump Name	CLI #	Type	Thermosyphon	Controls Local	Controls DCS	Capacity	Powered From
QUENCH RECIRC	H-261-OGQ-P-3103-A H-261-OGS-P-3103-B	Centrifugal Centrifugal	X X	X X	X X	40 HP 390 GPM/173' TDH	MCC 7 MCC 8
SCRUBBER RECIRC	H-261-OGS-P-3304-A H-261-OGS-P-3304-B	Centrifugal Centrifugal	X X	X X	X X	20 HP 126 GPM/222' TDH	MCC 8 MCC 7
FILTER FEED	H-261-P-OGE-3615-A H-261-P-OGE-3615-B	Centrifugal Centrifugal	X X	X X	X X	30 HP 300 GPM/185' TDH 20 HP 75 GPM/60' TDH	MCC 5 MCC 5
FILTER CONCENTRATE	H-261-OGB-P-3605	Centrifugal	X	X	X	5 HP 75 GPM/75' TDH	MCC 5
BLOWDOWN TRANSFER #1	H-261-OGB-P-3804	Centrifugal		X		5 HP 75 GPM/75' TDH	MCC 5
BLOWDOWN TRANSFER # 2	H-261-OGB-P-4104	Centrifugal	X	X		5 HP 75 GPM/75' TDH	MCC 5
CAUSTIC TRANSFER	H-261-CAUS-P-3104 H-261-CAUS-P-3208 H-261-CAUS-P-3904	Diaphram Diaphram Diaphram		X		1 HP 160 GPM/125' TDH	MCC 7 MCC 8 MCC 8
CAUSTIC UNLOADING	H-262-CAUS-P-0053	Centrifugal	X	X	X	5 HP 50 GPM/125' TDH	MCC 3

Table 4 Offgas Pump Comparisons

INSTRUMENTATION

ELO 3.03	**Given values for key performance indicators, DETERMINE if OFFGAS System components are functioning as expected.**
ELO 3.04	**DESCRIBE the following OFFGAS System instrumentation including, indicator location (local or Control Room) sensing points and associated instrument controls.** **a. Flow and Density** **b. Pressure** **c. Temperature** **d. pH and Conductivity** **e. Level and Specific Gravity** **f. Stack Emissions**
ELO 3.05	**INTERPRET the following OFFGAS System alarms, including the conditions causing alarm actuation and the basis for the alarms:** **a. Flow and Density** **b. Pressure** **c. Temperature** **d. pH and Conductivity** **e. Level and Specific Gravity** **f. Stack Emissions**
ELO 3.07	**DESCRIBE the interlocks associated with the following OFFGAS System equipment to include the interlock actuating conditions, effects of interlock actuation, and the reason the interlock is necessary.** **a. Quench Vessel** **b. Scrubber** **c. Quench Recirculation Pumps** **d. Scrubber Recirculation Pumps** **e. Induced Draft Fans** **f. Caustic pumps**

Instruments and Alarms

All instrumentation in the offgas area will be monitored and/or controlled by the DCS system. The parameters that are monitored by the instrumentation in the offgas area are:

- Flow and Density
- Pressure
- Temperature
- pH and Conductivity
- Level and Specific Gravity
- Stack Emissions

There are one hundred thirty two (132) alarms on the DCS provided by the Offgas instrumentation. Thirty three (33) of these alarms actuate an interlock. The rest of the alarms provide operations with time to address an abnormal condition before it actuates an interlock. The alarms with interlocks will be described in the discussion of the associated instrument. See Figures 21 - 31 (at the end of this section) for the instruments associated with each offgas system. Appendix A is a complete listing of the Offgas alarms and setpoints.

Flow and Density

System Flow and Density are monitored in :

- Quench Recirculation line to the spray nozzles
- Scrubber Recirculation line to the Scrubber
- Filter Recirculation to the Filter Feed Tank

Quench Recirc Flow (PT-OGQ4007XC-1)

Quench Recirc Flow, in the line from the Quench Recirc Pumps to the Quench Vessel Spray Nozzles, is measured by mass flow meter H-261-OGQ-FT-4007 which provides a signal to DCS for indication and alarm. Alarm OGQ4007FA LOW OGQ Recirc Flow (296 GPM) initiates a waste feed cutoff.

Scrubber Recirc to Quench Flow (PT-OGS3310F-1)

The flow from the Scrubber Recirc Tank to the Quench System (Quench Vessel or Quench Recirc Tank) is monitored by Mag Flow Meter H-261-OGS-FT-3310 which provides a signal to DCS for indication and alarm.

The density of the process liquid from the Scrubber Recirc Tank to the Scrubber is monitored by Mass Flow Meter H-261-OGS-FT-3308 which provides a signal to DCS for indication and alarm.

Filter Recirc Flow (PT-OGB3610X-1)

The flow of the filter recirc from the Crossflow Filter to the Filter Feed Tank is monitored by Mass Flow Meter H-261-OGB-FT-3610 which provides a signal to DCS for indication and alarm.

The density of the filter recirc from the filter to the Filter Feed Tank is monitored by Mass Flow Meter H-261-OGB-FT-3610 which provides a signal to DCS for indication and alarm.

Flow only is monitored in:

- Quench Vessel Headers
- Service Water to Scrubber Recirculation Tank
- Scrubber Recirculation to Quench System
- Filterate to Quench Recirculation Tank
- Steam Flow to Scrubber

Quench Vessel Header Flows (PT-OGQ4106)

For each of the five quench nozzle ring headers the following flow instrumentation is provided: flow element, local flow indicating transmitter, DCS flow indicator, flow switch and flow alarm. Fluid flow rate is measured by Mag Flow Meters and monitored by H-261-OGQ-FIT-4016, -4017, -4018, -4019, -4020 which allow periodic confirmation of adequate flow through the quench spray ring headers.

Scrubber Recirc to Scrubber Flow (PT-OGS3308F-1)

The flow from the Scrubber Recirc Tank to the Scrubber is monitored by Mass Flow Meter H-261-OGS-FT-3308 which provides a signal to DCS for indication and alarm. Alarm OGS3308FA-1 LOW Flow to OGS (51 GPM) starts the standby Scrubber Recirc. Pump and inhibits H-261-CAUS -P -3208, Caustic Pump No. 2. Alarm OGS3308FA LOW LOW Flow to OGS initiates a waste feed cutoff. The flow input from FT-3308 is also recorded on H-261-OGS-FR-3308 at Panel 2405B.

Steam Flow to Scrubber (PT-OGS3006FC-1)

The steam flow to the scrubber is monitored by H-261-HS-FT-3006 which provides a signal to DCS for indication control, and alarms. Alarm OGS3206FA LO LO Steam Flow (>6000 LB/HR) initiates a waste flow cutoff.

Service Water to Scrubber Recirc Tank Flow (PT-OGS3300F-1)

Service Water Flow to the Scrubber Recirc Tank is monitored by Mag Flow Meter H-261-SW-FT-3300 which provides a signal to DCS for indication and totaling

Filtrate Flow to Quench Recirc Tank (PT-OGB3711FC-1)

Filtrate flow rate is measured by Mag Flow Meter H-261-OGB-FT-3711 which provides a signal to DCS Controller/Indicator H-261-OGB-FC-3711. and alarms. The flow signal is compared to the setpoint of the controller and positions valve H-261-OGB-FCV-3711 as needed to maintain the desired flow. Alarm OGB3711FA LOW Flow Filterate (0.35 GPM) initiates a backwash cycle.

To start filtrate flow, the operator must select the Start Filtration Push-button (PB-3711) on DCS. This action will start filtration flow at 1 gpm. The flow rate will automatically increase by 1 gpm every hour until the preset flow rate is established. This process will also occur after backwash, with the controller automatically establishing 1 gpm flow and increasing by 1 gpm every hour until the desired flow is re-established.

ELO 3.04	**DESCRIBE the following OFFGAS System instrumentation including, indicator location (local or Control Room) sensing points and associated instrument controls.** **b. Pressure**
ELO 3.05	**INTERPRET the following OFFGAS System alarms, including the conditions causing alarm actuation and the basis for the alarms:** **b. Pressure**

<u>System Pressure</u>

System pressures monitored include differential pressure across major pieces of equipment, other flowpath pressures, and equipment internal pressures.

Differential Pressure (DP)

Differential pressure is monitored across major pieces of equipment throughout the Offgas System including:

- SCC to Quench Vessel
- Quench Vessel to Scrubber Inlet
- Across the Scrubber
- Scrubber to Cyclone Separator
- Across the Mist Eliminator
- Across the Reheater
- Across the HEPA Filters

SCC to Quench Vessel DP (PT- OGQ4003P-1)

The differential pressure from the outlet of the SCC to the outlet of the Quench Vessel is monitored by DP Transmitter H-261-OGQ-PT-4003 which sends a signal to the DCS for indication and alarm. This will determine if water is building up in the Quench.

Quench Vessel to Scrubber DP (PT-OGS3003P-1)

The DP from the outlet of the Quench Vessel to the inlet of the Scrubber is monitored by DP Transmitter H-261-OGS-PT-3001 which provides a signal to DCS for indication and alarm

Scrubber Inlet to Scrubber Outlet DP (PT-OGS3201P-1)

The DP from the inlet of the Scrubber to the Outlet of the Scrubber is monitored by DP Transmitter H-261-OGS-PT-3003 which provides a signal to DCS for indication and alarm

Scrubber Outlet to Cyclone Separator Outlet DP (PT-OGS3206P-1)

The DP from the outlet of the Scrubber to the outlet of the Cyclone Separator is monitored by DP Transmitter H-261-OGS-PT-3201 which provides a signal to DCS for indication and alarm Local indication is provided by H-261-OGS-PI-3205.

Mist Eliminator DP (PT-OGE3400P-1)

The DP from the inlet of the Mist Eliminator to the outlet of the Mist Eliminator is monitored by DP Transmitter H-261-OGS-PT-3206 which provides a signal to DCS for indication and alarm. Local indication is provided by H-261-OGS-PDI-3200

Reheater DP (PT-OGE3400P-1)

The DP across the Reheater is monitored by DP Transmitter RHTR-001, H-261-OGE-PDT-3400 which provides a signal to DCS for indication and alarm. DP is an indication of salt and particulate buildup on the coils of the reheater/mist eliminator.

HEPA Filter DP (PT-OGE3403P-1)

Six (6) DP indicators are provided on the filters (H-261-OGE-PDI-2005-(A-B), H-261-OGE-PDI-2006-(A-B), and H-261-OGE-PDI-2007-(A-B). The DP from the Inlet of the HEPA Filters to the Outlet of the HEPA Filters is monitored by DP Transmitter H-261-OGE-PDT-3403 which provides a signal to DCS for indication and alarm

Other Flowpath Pressure

Other pressures monitored include:

- Quench Vessel 1st Nozzle Ring
- Emergency Service Water
- Steam to Scrubber
- Cyclone Separator Outlet
- ID fan
- Filterate
- Filterate Filter Backpressure
- Pump Themosyphon (Seal) Tanks

Quench Vessel 1st Nozzle Ring Pressure

The pressure of the 1st nozzle ring downstream of the Flow Element is detected and indicated locally by pressure indicator H-261-OGQ-PI-4004.

Emergency Service Water Pressure (PT-OGQ4000P-1)

The pressure in the Emergency Service Water Line to the Quench Vessel and Scrubber is monitored by pressure transmitter H-261-SW-PT-4000 which sends a signal to the DCS for a low pressure alarm, and for indication on H-261-SW-PI-4000.

Steam to Scrubber Pressure (PT-OGS3007P-1)

Steam pressure to the Scrubber is measured by Pressure Transmitter H-261-HS-PT-3007. A signal is provided to DCS for indication and alarm.

Cyclone Separator Outlet Pressure (PT-OGS3207PE-1)

The pressure in the Offgas Duct leaving the Cyclone Separator is monitored by three pressure transmitters in parallel, H-261-OGS-PT-3207-(A), -(B), & -(C). All three send a signal to the DCS for Controller/Indicator H-261-OGS-PIC-3207 for control of the ID Fan Integral dampers and for HIGH and HIGH-HIGH alarms. Alarm OGS3207PA-1 HIGH HIGH Cyclone Pressure (-1.0 INWC) initiates an incinerator shutdown.

The median value of the three pressure signals is compared to the highest transmitter value and to the lowest transmitter value. If any transmitter value deviates from the median value greater than the alarm threshold value (typically 15%) an alarm will be initiated indicating a transmitter failure. Each loop has an Auto/Manual control to enable manual control of each integral damper. Three transmitters are required to ensure that the Deflagration (fire) Containment design basis meets the NFPA-82 requirements. Local indication is provided by H-261-OGS-PI-3204.

ID Fan Pressure (PT-OGE3500P-1)

The pressure at the inlet header to the ID Fans is monitored by Pressure Transmitters, H-261-OGE-PT-3500-(A), -(B), & -(C) which provide DCS indication and alarm.

Filtrate Pressure (PT-OGB3717PE-1)

The pressure in the filtrate line from the Crossflow Filter to the Quench Recirc Tank is monitored by pressure transmitter H-261-OGB-PT-3717 which provides DCS indication on H-261-OGB-PI-3717 and an input to H-261-OGB-PDI-3717.

Filter Backpressure (PT-OGB3716PE-1)

Filter backpressure is monitored by pressure transmitter H-261-OGB-PT-3716 which sends a signal to DCS Controller/Indicator H-261-OGB-PIC-3716 and an input to H-261-OGB-PDI-3717. Also the DCS alarms low and high pressure indications.

Pump Thermosyphon (Seal) Tanks Pressure

The pressure in the Offgas Pumps fitted with Thermosyphon tanks is monitored locally. Loss of Tank pressure will trip the pump and prevent them from starting until the required pressure is restored.

ELO 3.04	**DESCRIBE the following OFFGAS System instrumentation including, indicator location (local or Control Room) sensing points and associated instrument controls.** **c. Temperature**
ELO 3.05	**INTERPRET the following OFFGAS System alarms, including the conditions causing alarm actuation and the basis for the alarms:** **c. Temperature**

Temperature

Temperature is monitored at:

- Quench Recirculation Line
- Scrubber Inlet and Outlet
- Scrubber Recirculation Line Reheater Inlet and Outlet
- I.D. Fan Outlet
- Caustic Storage Tank

Quench Recirc Temperature (PT-OGQ3108T-1)

Quench Recirc Temperature is monitored by RTD Sensor/Temperature Transmitter H-261-OGQ-TT-3108. This transmitter provides DCS indication and alarm.

Scrubber Inlet & Outlet Temperature (PT-OGS3002T-1 & PT-OGS3009T-1)

OGS temperature is monitored by redundant temperature elements and associated transmitters prior to the steam eductor and in the mixing tube. As with other instrumentation throughout the Offgas System, redundant instrumentation provides for reliable operation and associated safety functions. The temperature elements in the mixing tube monitor temperature and provide for initiation of emergency water to the system. Inlet temperature indication is provided on DCS Transmitter H-261-OGS-TI-3002-(A&B). Outlet temperature indication is provided on DCS Transmitter H-261-OGS-TI-3009-(A&B). Alarms OGS3002TA & 3009TA HIGH HIGH Inlet and Outlet temperatures (210° F) respectively, initiate a waste feed cutoff.

Scrubber Recirc Temperature (PT-OGS3309T-1)

The Scrubber Recirculation Pumps outlet temperature is monitored by RTD Sensor/Temperature Transmitter H-261-OGS-TT-3309. This instrument provides a signal to DCS for indication and alarm.

Reheater Inlet Temperature (PT-OGE3407T-1)

The temperature at the inlet to the Reheater (outlet of the Mist Eliminator) is monitored by RTD Sensor/Temperature Transmitter H-261-OGE-TT-3407 which sends a signal to DCS for indication (H-261-OGS-TI-3407).

Reheater Outlet Temperature (PT-OGE3401TC-1)

Reheater outlet temperature is monitored by DCS Temperature Transmitter H-261-OGE-TT-3401). The steam flow to the Reheater is adjusted automatically to maintain the desired temperature set on indicating controller H-261-MS-TIC-3401. In addition to the control functions, the transmitter provides signals for alarms,

Offgas Discharge Temperature (PT-OGE3510T-1)

An RTD Sensor/Temperature Transmitter (H-261-OGE-TT-3510) is provided downstream of the extractive monitoring port. This transmitter provides alarms on the DCS.

Caustic Storage Tank Temperature (PT-CAUS3900T-1)

The Caustic Tank temperature is monitored by RTD Sensor/Temperature Transmitter H-261-CAUS-TT-3900. This instrument provides a signal to the DCS for indication (H-261-CAUS-TI-3900) and alarms.

ELO 3.04	**DESCRIBE the following OFFGAS System instrumentation including, indicator location (local or Control Room) sensing points and associated instrument controls.** **d. pH and Conductivity**
ELO 3.05	**INTERPRET the following OFFGAS System alarms, including the conditions causing alarm actuation and the basis for the alarms:** **d. pH and Conductivity**

pH and Conductivity:

The flue gas is acidic (primarily due to the HCl (Hydrochloric Acid) content) due to the incineration of chlorides. The pH level must be closely controlled to ensure that the system functions as design. The conductivity measurement provides for control of dissolved solids, principally NaCl (salt). The suspended solids' level in the quench is controlled by sampling and operating the filter system as required. pH and conductivity are monitored in the quench and scrubber recirculation lines only.

Offgas Quench Conductivity and pH (PT-OGQ3104X-1&OGQ3109X-1)

The OGQ System pH must be maintained at or below a pH of 5- 7.5 (acid range) to minimize CO2 absorption and chemical formation of sodium bicarbonate (NaHCO3) which would add to the blowdown waste. In addition, operation of the OGQ System in the acid range prevents scale buildup within the OGQ System. It is estimated that 75% of flue gas acid will be absorbed and transferred to the quench liquid. Provisions have been made to allow caustic addition directly to the OGQ Recirc Tank.

Quench pH and conductivity are measured in a separate loop that re-circulates liquid from the pump discharge back to the Quench Recirc Tank. There are two conductivity (H-261-OGQ-CE-3109-A&B) and two pH (H-261-OGQ-AE-3104-A&B) elements, each in a separate branch, providing input to indicating transmitters (H-261-OGQ-AIT-3104-A&B and H-261-OGQ-CT-3109-A&B) as well as local indication. This arrangement provides 100% redundancy for each instrument. All four branches remain in service at all times except for maintenance and calibration

Offgas Scrubber Conductivity and pH (PT-OGS3208X-1&3205X-1)

The OGS System must be maintained at or below a pH of 5 - 7.5 (acid range). 20% NaOH is added directly to the Scrubber nozzles to ensure acid removal from the flue gas. For this reason caustic is added to the OGS System. The addition of caustic to the OGS System is controlled by Scrubber System pH.

Similar to the arrangement for the Quench Recirc, Scrubber pH and conductivity are measured in a separate loop that recirculates liquid from the pump discharge back to the Scrubber Recirc Tank (Figure 8, Offgas Scrubber Recirc). There are two conductivity (H-261-OGS-CE-3305-A&B) and two pH (H-261-OGS-AE-3208-C&D) elements, each in a separate branch, providing input to Indicating Transmitters (H-261-OGS-AIT-3208-C&D and H-261-OGS-CT-3305-A&B),alarms and local indications. This arrangement provides 100% redundancy for each instrument. All four branches remain in service at all times except for maintenance and calibration.

Cyclone Separator Drain Line pH (PT-OGS3208X-1)

Control of caustic addition is normally accomplished utilizing the measurement obtained from the Cyclone Separator Drain Line (H-261-OGS-AE-3208-A&B, Figure 7, Cyclone Separator and Mist Eliminator) but can be controlled using the measurements obtained from the Scrubber Recirculation Tank. Alarm OGS3208XA-6 Low Low Scrubber Recirc Tank pH (4.5 pH) initiates a waste feed cutoff.

ELO 3.04	**DESCRIBE the following OFFGAS System instrumentation including, indicator location (local or Control Room) sensing points and associated instrument controls.** **e. Level and Specific Gravity**
ELO 3.05	**INTERPRET the following OFFGAS System alarms, including the conditions causing alarm actuation and the basis for the alarms:** **e. Level and Specific Gravity**

Level and Specific Gravity

Tank level and specific gravity is monitored, using plant air bubbler tubes, on the following tanks:

- Quench Recirc Tank
- Scrubber Recirc Tank
- Filter Feed Tank
- Blowdown Hold Tanks No. 1 & 2

Level is density corrected using the specific gravity. If the specific gravity indication is < 0.7 it is automatically valued at 0.7 for the density correction by the DCS. If actual tank level falls below 20 inches, the specific gravity value is held at the value prior to level falling below 20 inches.

Quench Recirc Tank Level (PT-OGQ3100LC-1)

Quench Recirc Tank Level is monitored by DP transmitter H-261-OGQ-LT-3100. Specific Gravity for the tank is monitored by DP transmitter H-261-OGQ-DT-3100. Level indication, to the DCS, is provided on Controller Indicator H-261-OGS-LIC-3100. Alarms and the associated interlocks provided by this instrumentation are:

- OGQ3100LA -1 LO LO Level (24”) inhibits the tank agitator;
- OGQ3100LA LO LO LO Level (18”) inhibits both quench pumps;

Scrubber Recirc Tank Level (PT-OGS3301LC-1)

The level in the Scrubber Recirc Tank must be maintained at 70 in. to ensure that there is adequate liquid available to the Scrubber. Service Water is automatically added to maintain level.

Scrubber Recirc Tank Level is monitored by DP transmitter H-261-OGS-LT-3301. Specific Gravity for the tank is monitored by DP transmitter H-261-OGS-DT-3301. Level indication, on the DCS, is provided on Controller Indicator H-261-SW-LIC-3301. Specific Gravity indication is provided (H-261-OGS-DI-3301). Alarms and the associated interlocks are:

- OGS3302LA-3 HIGH Level (96”) closes H-261-SW-LCV-3301 Level Control to OGS-TK-001;
- OGS3301LA-2 LOW LOW Level (32”) inhibits the agitator;
- OGS3301LA-2 LOW LOW LOW (18”) inhibits the scrubber recirc pumps.

Filter Feed Tank Level (PT-OGB3600L-1)

Filter Feed Tank level is monitored by DP transmitter H-261-OGB-LT-3600. Specific Gravity for the Filter Feed Tank is monitored by DP Transmitter H-261-OGB-DT-3600. Indication, on the DCS, is provided for level (H-261-OGB-LI-3600) and specific gravity (H-261-OGB-DI-3600). Alarms and the associated interlocks are;

- OGB3600LA-2 LOW LOW Level (24”) inhibits Filter Feed Pumps No. 1& 2, H-261-OGB-P-3615 A&B;
- OGB3600LA-1 LO-LO-LO Level (18”) inhibits the Filter Feed Tank agitator;
- OGB3600LA L-L-L-L Level (12”) inhibits the Filter Concentrate Pump;
- OGB3600LA-5 HI HI level (105”) inhibits H-261-OGQ-FV-3607, to TK-003 Flow Valve.

Blowdown Hold Tank Level (PT-OGB3801L-1&OGB4100L-1)

Blowdown Hold Tank No. 1 level is monitored by DP transmitter H-261-OGB-LT-3800. Specific Gravity for Blowdown Hold Tank No. 1 is monitored by DP transmitter H-261-OGB-DT-3800. Indication, on the DCS, is provided for level (H-261-OGB-LI-3800) and specific gravity (H-261-OGB-DI-3800). Local indication is provided on H-261-OGB-LI-3800-(B). Alarms and the associated interlocks are;

- OGB3800LA-1 LOW level (24”) stops the tank agitator;
- OGB3800LA LO LO (18”) inhibits transfer pump No. 1
- OGB3800LA-3 HI HI & OGB3801LA H H H (105”) inhibit H-261- OGQ- FV-3802 to OGB-TK-001 Flow Valve

Blowdown Hold Tank No. 2 level is monitored by DP transmitter H-261-OGB-LT-4100. Specific Gravity for Blowdown Hold Tank No. 2 is monitored by DP Transmitter H-261-OGB-DT-4100. Indication, on the DCS, is provided for level [H-261-OGB-LI-4100-(A)] and specific gravity (H-261-OGB-DI-4100). Local indication is provided on H-261-OGB-LI-4100-(B). Alarms and the associated interlocks are;

- OGB4100LA LO LO (18”) inhibits the tank agitator;
- OGB4100LA-3 HI HI & OGB4101LA H H H (105”) inhibit H-261-OGQ-FV-4102, from Recirc Pump to OGB-TK-002 Flow Valve

Level Only

Quench Vessel Level (PT-OGQ4012L-1)

Quench Vessel Level is monitored by DP transmitter H-261-OGQ-LT-4012. It provides a signal to DCS for indication and alarm.

Caustic Storage Tank Level (PT-CAUS3902L-1)

Caustic Storage Tank level is monitored by DP transmitter H-261-CAUS-LT-3902. Alarms and the associated interlocks are;

- CAUS3902LA-1 LO LO (24”) inhibits Caustic Pumps Nos. 1,2,&3;
- CAUS3902LA-3 High Level (102”) & CAUS3901LA HI HI HI Level (105”) inhibit H-262-CAUS-P-0053, Caustic Unloading Pump.

ELO 3.04	**DESCRIBE the following OFFGAS System instrumentation including, indicator location (local or Control Room) sensing points and associated instrument controls.** **f. Stack Emissions**
ELO 3.05	**INTERPRET the following OFFGAS System alarms, including the conditions causing alarm actuation and the basis for the alarms:** **f. Stack Emissions**

Stack Emissions Instrumentation

Extractive Gas Sampling Monitor (PT-OGE3501X-1 & 3518X-1)

Oxygen (O2) and Carbon Monoxide (CO) levels in the Offgas Duct, prior to the stack, are monitored by redundant Extractive Gas Sampling Systems 3501 and 3518. Each of these systems provides three signals to the DCS, two for CO and one for O2.

DCS indications for the Extractive Gas Sampling Monitors are provided as follows:

- CO level - H-261-OGE-AI-3501-(A&C), H-261-OGE-AI-3518-(A&C)
- O2 level - H-261-OGE-AI-3501-(B) and H-261-OGE-AI-3518-(B)

Alarms and the associated interlocks are;

- OGE3501XA-1 and OGE3518A-1 HIGH HIGH CO Level (120 ppm) initiates a waste feed cutoff.

Offgas Radiation Sample

An isokinetic sample system monitors particulate radiation downstream of the temperature transmitter just prior to entry into the stack. This equipment is part of the Stack Air Activity Monitor System.

Summary

- The six (6) parameters OFFGAS instrumentation provides indications for are:
  - Flow and Density
  - Pressure
  - Temperature
  - pH and Conductivity
  - Level and Specific Gravity
  - Stack Emissions
- Density, pH and conductivity, and specific gravity indications are monitored in the control room on the DCS. All other indications can also be monitored locally.
- The DCS provides automatic control functions for offgas operations that could adversely affect safety.
- Tank level alarms initiate interlocks that inhibit pumps, agitators, and valves.
- Some of the other parameter alarms initiate interlocks that cause a waste feed cutoff.

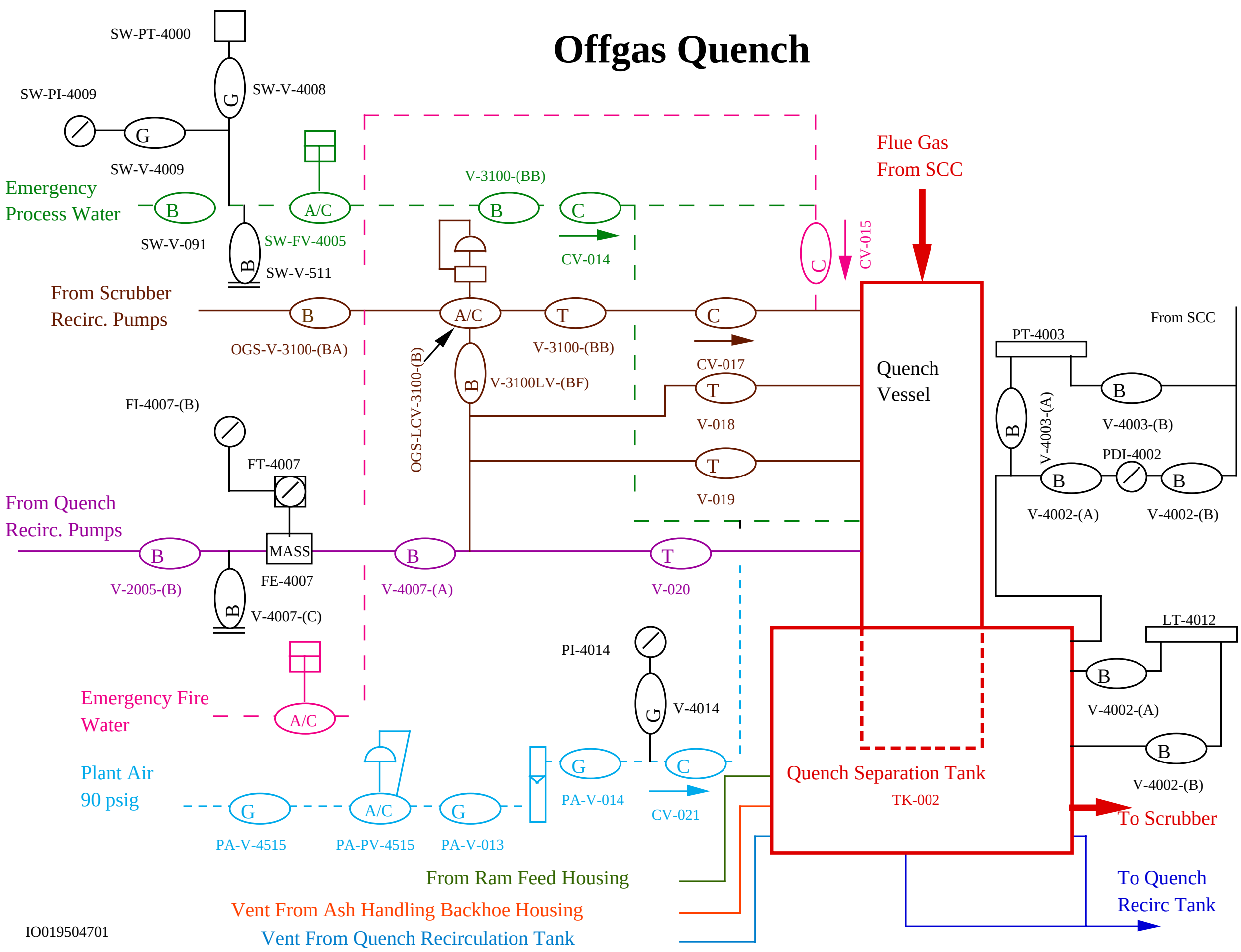


Figure 21 Offgas Quench Instrumentation

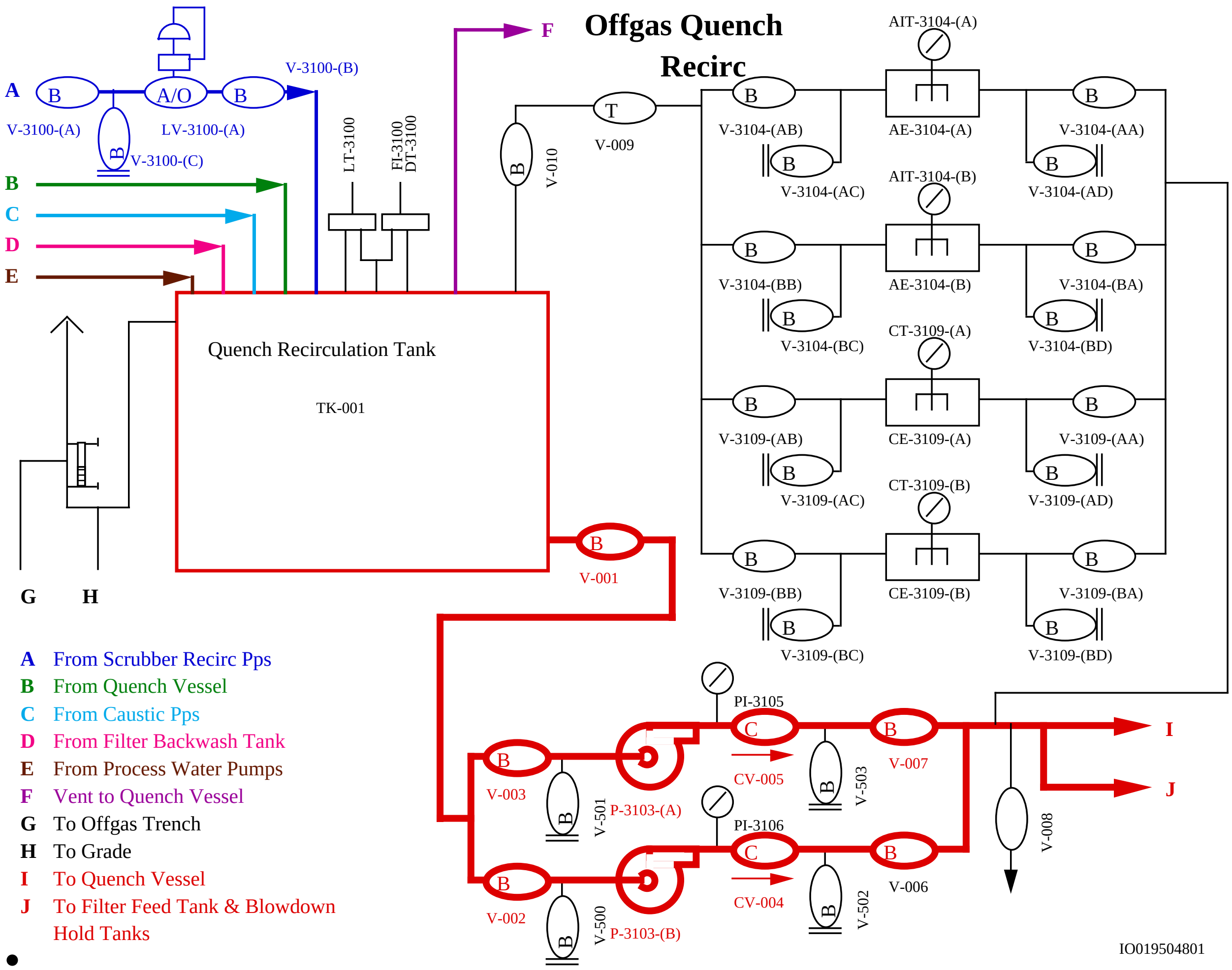


Figure 22 Offgas Quench Recirc Instrumentation

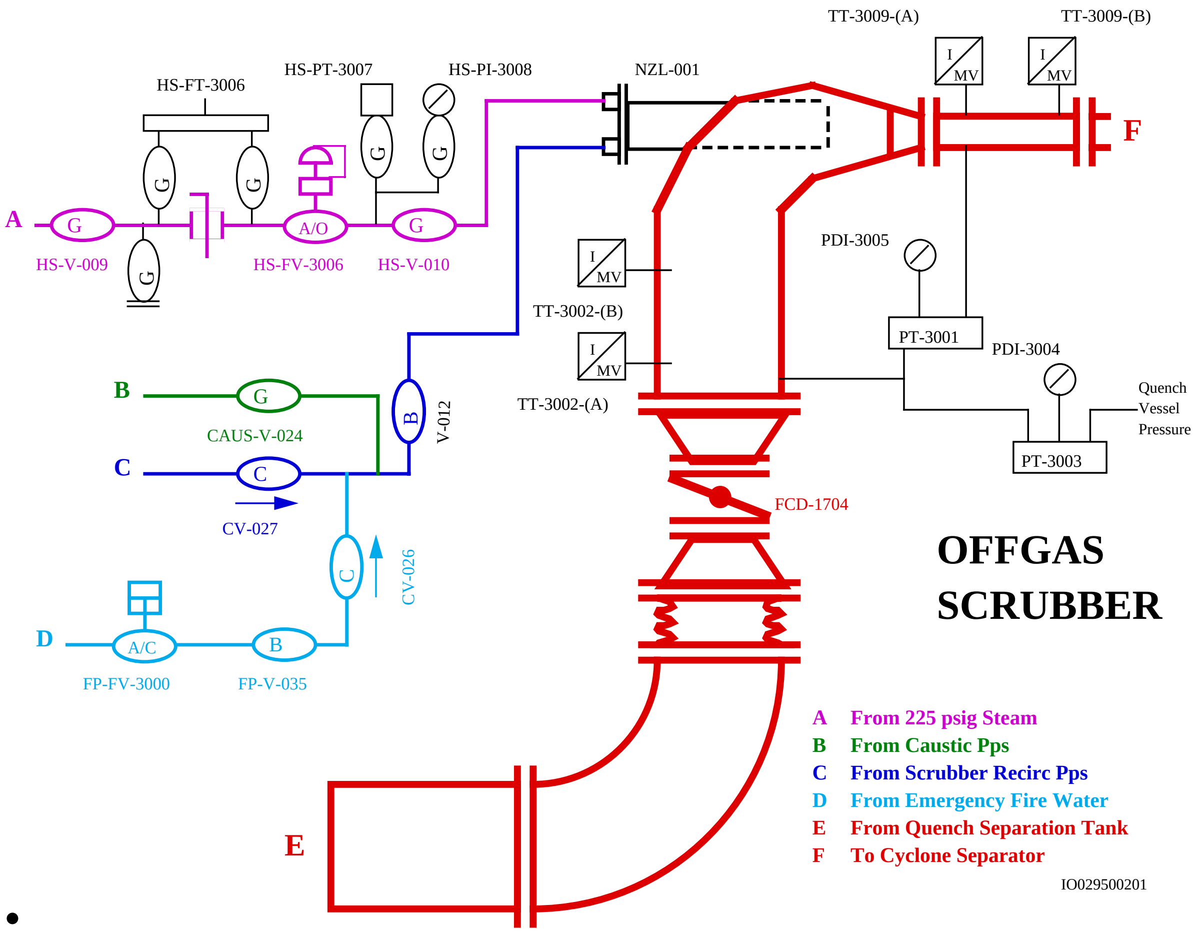


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Figure 23 Offgas Scrubber Instrumentation

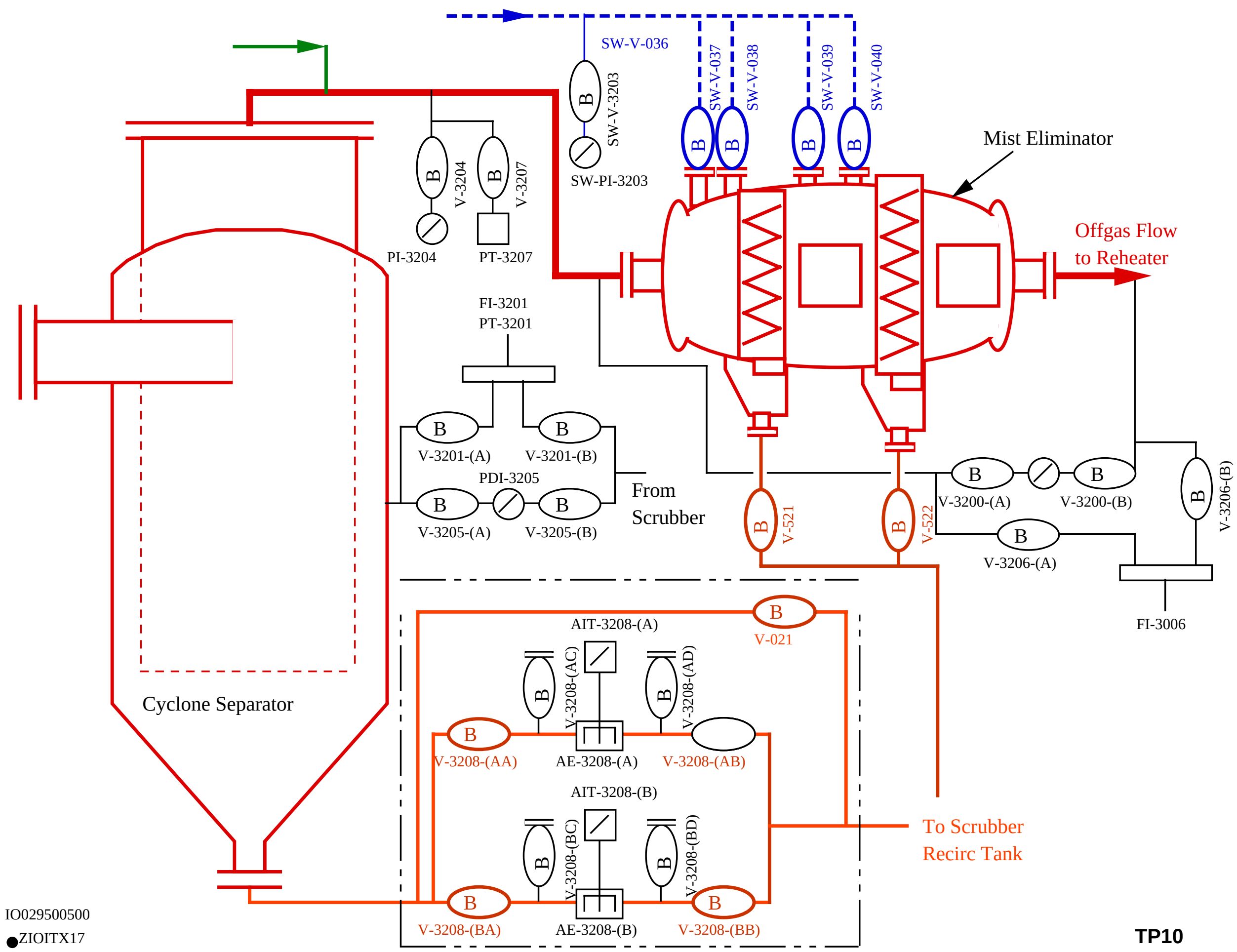

Figure 24 Cyclone Separator and Mist Eliminator Instrumentation

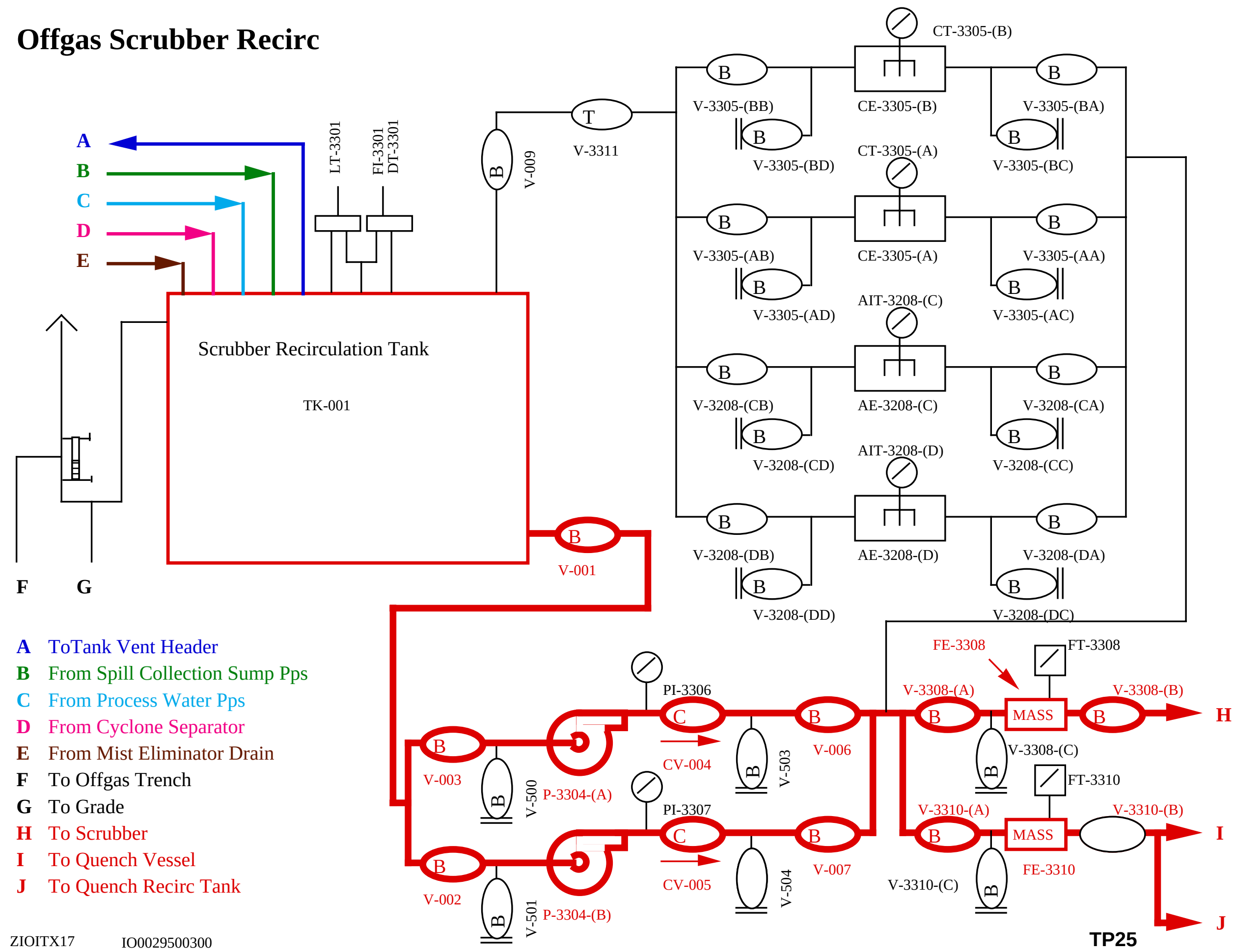

Figure 25 Offgas Scrubber Recirc Instrumentation

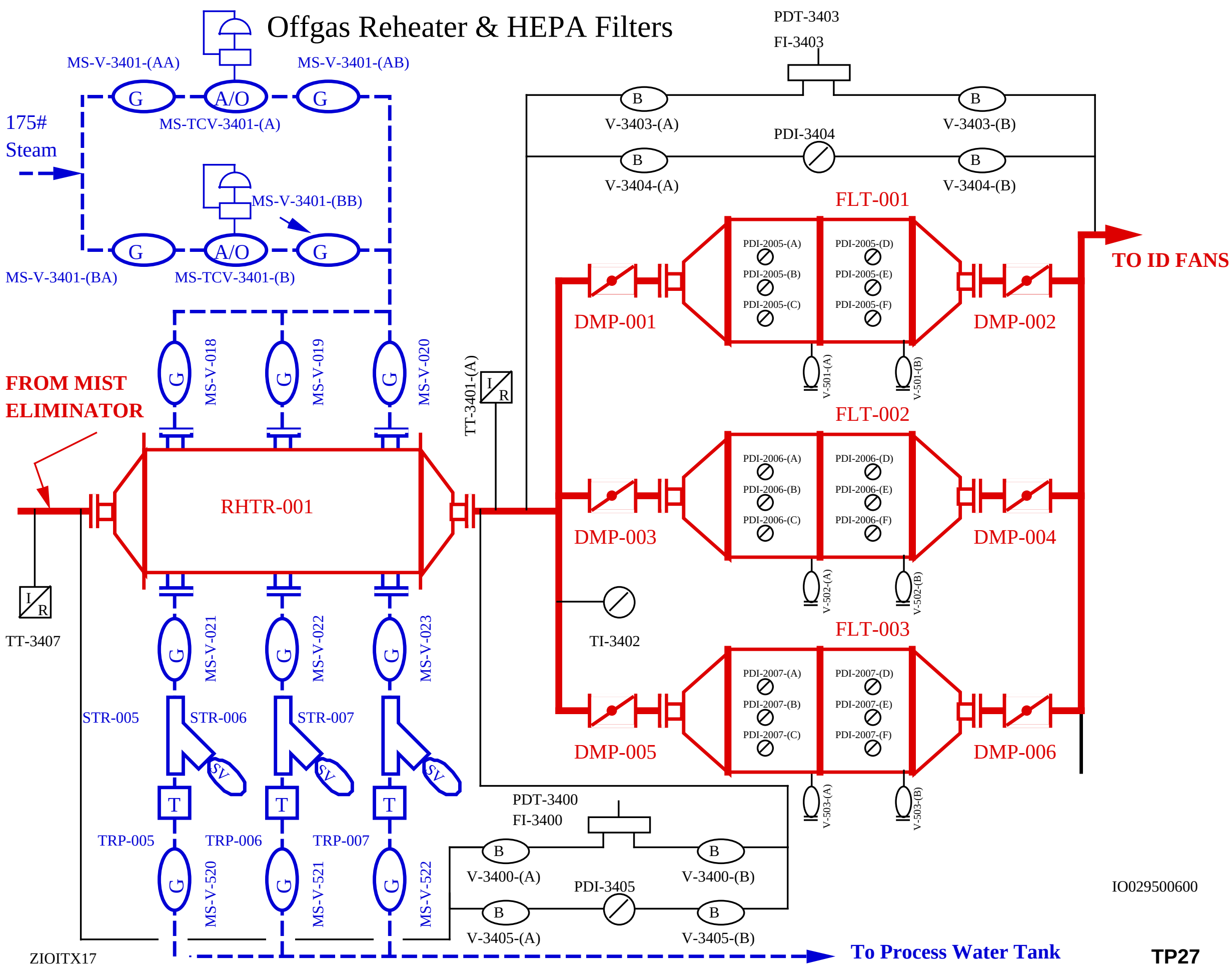

Figure 26 Offgas Reheater and HEPA Filters Instrumentation

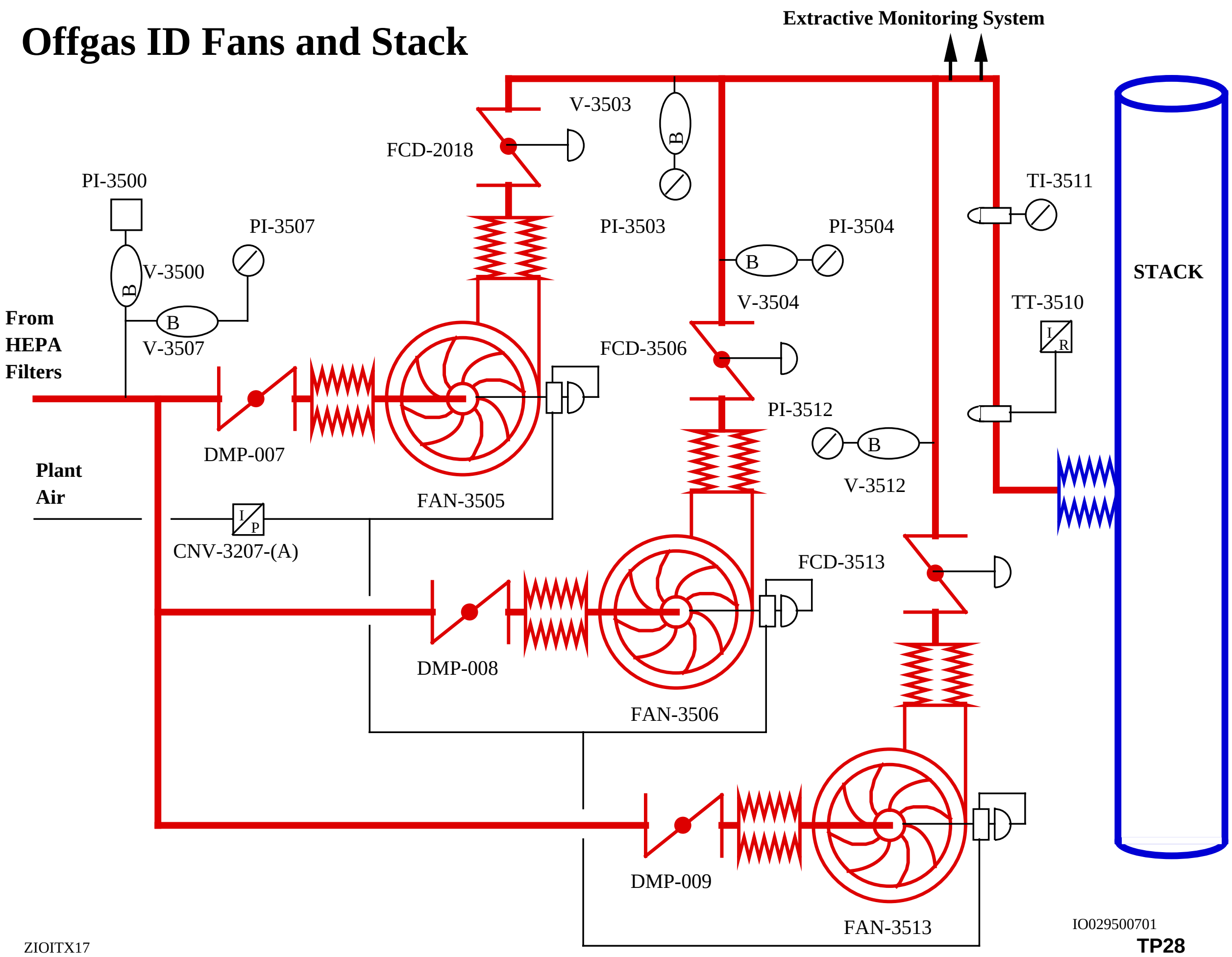

Figure 27 Offgas ID Fans and Stack Instrumentation

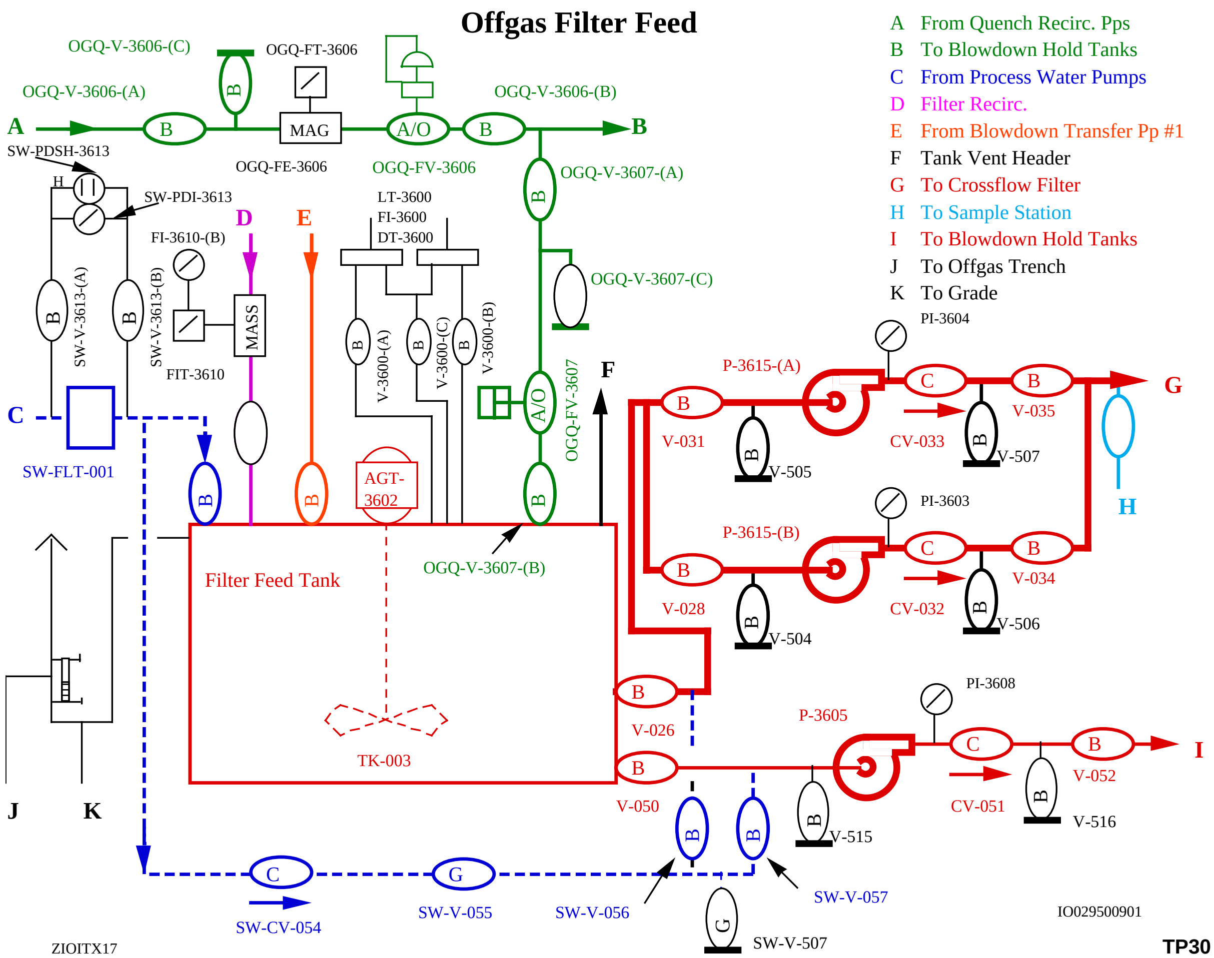

Figure 28 Offgas Filter Feed Instrumentation

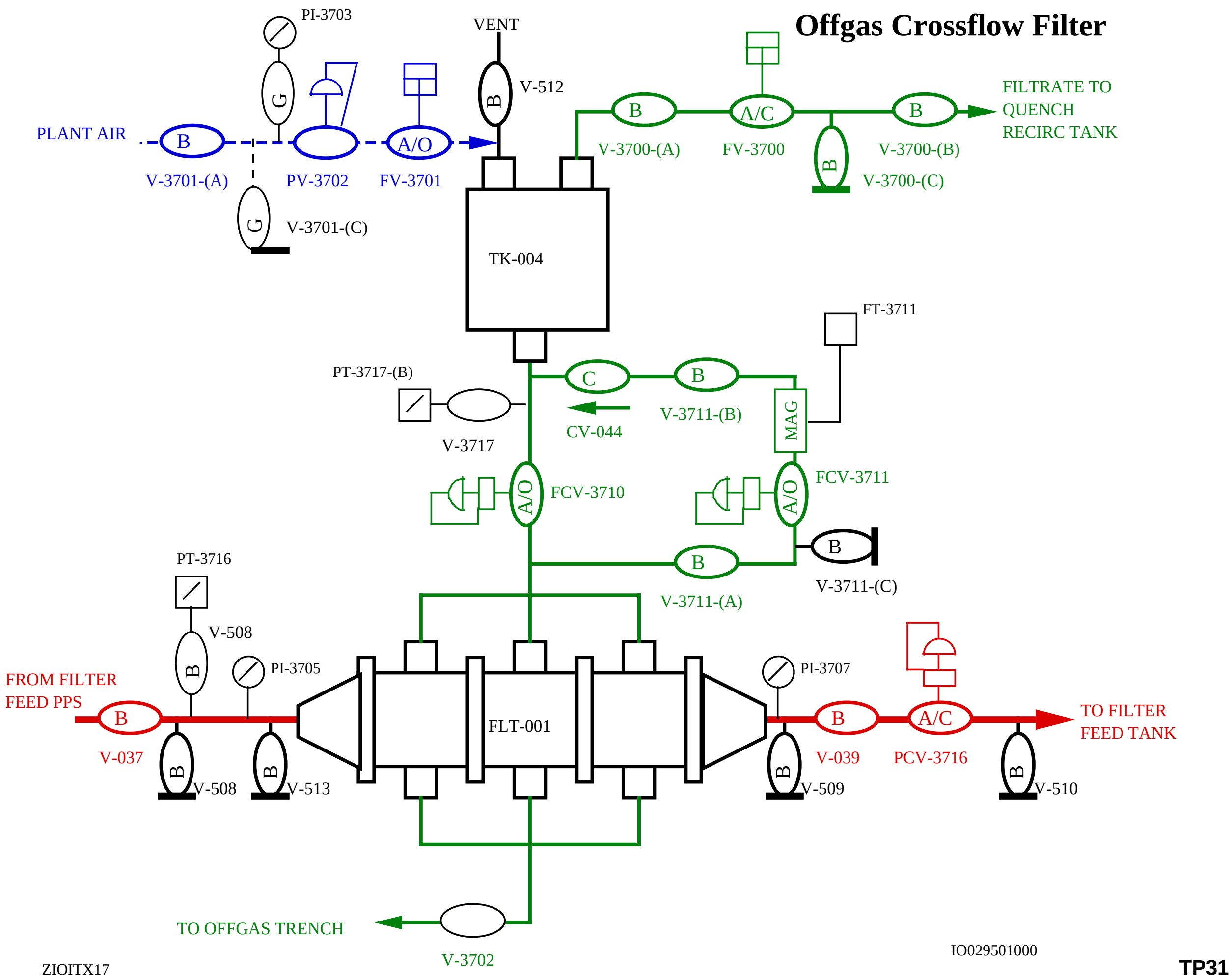

Figure 29 Offgas Crossflow Filter Instrumentation

Offgas Blowdown

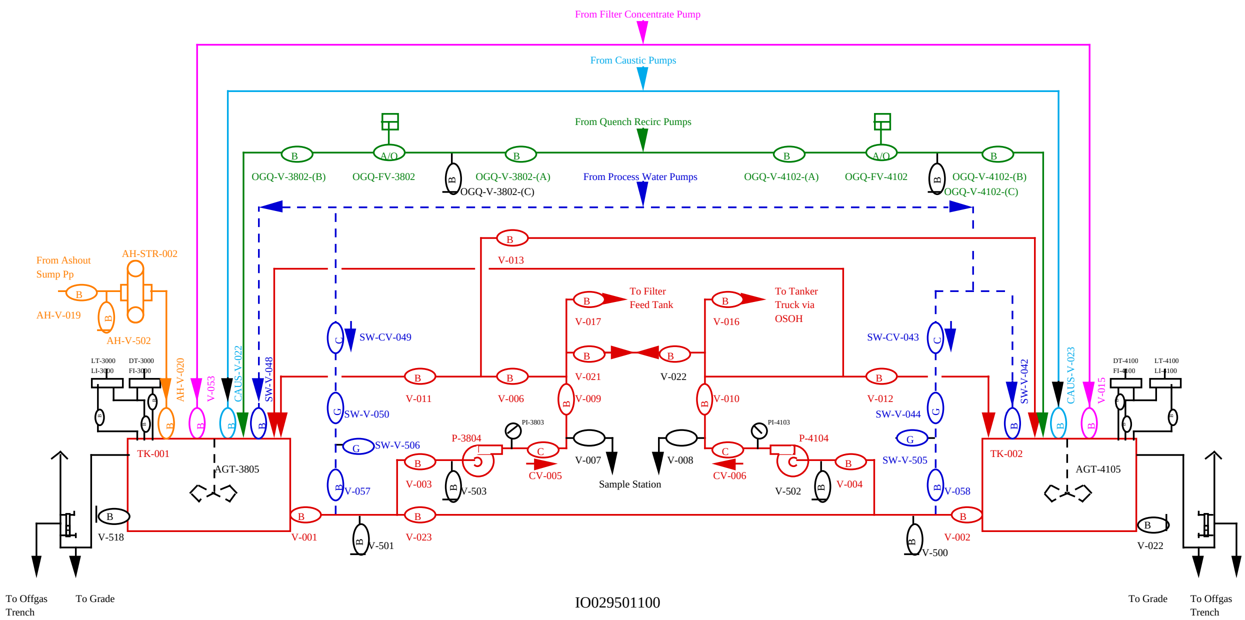

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Figure 30 Offgas Blowdown Instrumentation

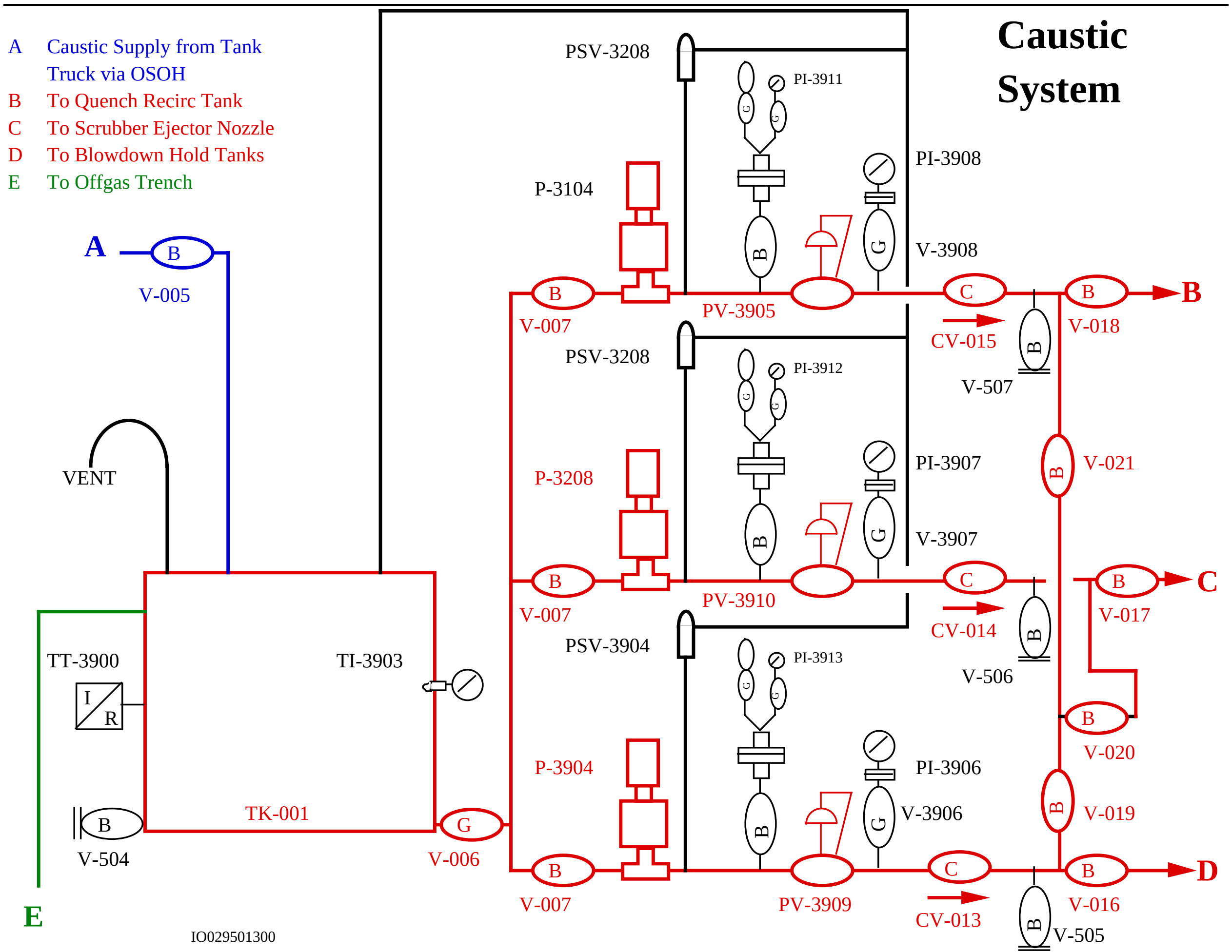

Figure 31 Caustic System Instrumentation

CONTROLS, INTERLOCKS, AND LIMITS

ELO 3.06	**EXPLAIN how the following OFFGAS System equipment is controlled in all operating modes or conditions to include: control locations (local or Control Room), basic operating principles of control devices, and the effects of each control on the component operation.** **a. Pumps** **b. Valves** **c. Tanks**

Controls

Control loops provide automatic control, by the DCS/PLC System, for the following: The main component associated with the control system is listed behind the loop.

- Scrubber Recirc to Quench Vessel (H-261-OGS-LCV-3100-(B)
- Scrubber Recirc to Quench Recirc Tank (H-261-OGS-LV-3100-(A)
- Caustic to Quench Recirc Tank (H-261-CAUS-P-3104)
- Caustic to Scrubber (H-261-CAUS-P-3208)
- Steam to Scrubber (H-261-HS-FV-3006)
- Make up water Scrubber Recirc Tank (H-261-OGS-LV3301)
- Reheater Steam [H-261-MS-TCV-3401-(A&B)]
- Offgas System Pressure (H-261-CAUS-P-3904)
- Blowdown from Quench Recirc Tank (H-261-OGQ-FV-3606)
- Filter Back Pressure (H-261-OGB-FCV-3711)

Scrubber Recirc to Quench Vessel and Recirc Tank

The level of the Quench Recirc Tank is compared to the setpoint of DCS Controller H-261-OGS-LIC-3100 (the operator determines the setpoint). The output of the controller can be directed to valve H-261-OGS-LV-3100-(A) or H-261-OGS-LCV-3100-(B) by DCS selector switch H-261-OGS-HS-3100. The selected valve controls make up liquid flow from the Scrubber Recirc Tank to the Quench Recirc Tank. Valve H-261-OGS-LV-3100-(A) controls the amount of liquid that is directed from the Scrubber Recirc Tank directly to the Quench Recirc Tank. Valve H-261-OGS-LCV-3100-(B) controls the flow from the Scrubber Recirc Tank to the first spray ring on the Quench Vessel.

Caustic to Quench Recirc Tank

Selector Switch H-261-OGQ-3104-HS on the DCS is provided to select which pH transmitter input is sent to DCS controller H-261-OGQ-AIK-3104. The pH signal is compared to the setpoint of the controller and the Caustic Metering pump H-261-CAUS-P-3104 is controlled by the output of the controller.

Caustic to Scrubber Recirc Tank

Selector Switch H-261-OGS3208-HS2 on the DCS is provided to select which pH transmitter input is sent to DCS controller H-261-OGS-AIK-3208XE2. The pH signal is compared to the setpoint of the controller and the Caustic metering pump H-261-CAUS-P-3208 is controlled by the output of the controller.

Caustic Pumps

Caustic pump H-261-CAUS-P-3104 provides caustic addition to the OGQ Recirc Tank and is controlled by the pH instruments located in the Quench Recirculation Pumps discharge line. This control maintains the pH above 5 which minimizes hydrochloric acid (HCl) sent to the scrubber.

Caustic Pump H-261-CAUS-P-3208 supplies caustic solution to the scrubber nozzle to adjust the scrubber solution pH. The pump is controlled by a signal from the pH meters in the Scrubber Recirculation Tank drain line to maintain the pH above 8. This allows for increased filtering of salts.

Caustic pump H-261-CAUS-P-3904 feeds caustic solution to the Blowdown Hold Tanks to adjust blowdown waste pH. This pump is manually controlled based on the sample taken from the Blowdown Hold Tanks. In addition, this pump can also manually feed caustic to the Quench Recirculation Tank or to the Scrubber Eductor Nozzle.

Steam to Scrubber

Steam flow rate to the Scrubber is controlled by valve H-261-HS-FV-3006 which is controlled by DCS Controller H-261-HS-FIC-3006. The flow signal from H-261-HS-FT-3006 is compared to the setpoint of the controller (6500 to 20,000 lbs/hr) and, if necessary, a signal is sent to open or close the valve.

Make Up Water to Scrubber Recirc Tank

Scrubber Recirc Tank Level is controlled by Controller/Indicator H-261-SW-LIC-3301. After comparing actual level to the setpoint of 70%, H-261-SW-LIC-3301 sends a positioning signal to Service Water Valve H-261-SW-LCV-3301 to maintain the level in the tank.

Steam to Reheater

Temperature Transmitter, H-261-OGE-TT-3401 sends a signal to DCS Controller H-261-MS-TIC-3401 which compares the signal to the setpoint of the Controller. An output signal is sent to control the positioning of Steam Control Valves H-261-MS-TCV-3401-(A&B).

Offgas System Pressure

The ID Fans have integral dampers which provide for control of the system vacuum. The dampers, during normal operation, are controlled by pressure downstream of the Scrubber/Cyclone Separator through Controller/Indicator(s) H-261-OGS-PIC-3207-(A, -B & -C). The setpoint for the vacuum is 4.5 inches WC which maintains a vacuum of approximately 0.5 inches WC at the Scrubber Steam Eductor.

The auto start sequence of ID Fans consists of the following;

- Close the integral damper and the discharge damper
- automatic start of the ID Fan
- discharge damper opens automatically with the integral damper position controlled by the RK pressure.

Blowdown From Quench Recirc Tank

The density output from H-261-OGQ-FT-4007 is sent to DCS controller H-261-OGQ-4007 -FIC where it is compared to a density range set on the controller (set by operator). The output signal will provide blowdown of the Quench Recirc Tank when the setpoint is reached and continue blowdown until the desired density is reached.

The required 10-20 gpm blowdown flow is maintained by comparing the blowdown flow rate to that set on controller H-261-OGQ-FIC-3606. The controller sends an output signal to position valve H-261-OGQ-FV-3606 which controls blowdown flow. There are two inputs to the controller, one from the conductivity controller H-261-OGQ-CC-3109 and the other from density controller H-261-OGQ-FIC-4007.

Selector Switch H-261-OGS- 3305-HS, on the DCS, provides the means for selecting which OGS conductivity transmitter provides alarms, indicated in Appendix A Offgas System Alarms .

Selector Switch H-261-OGQ- 3109-HS (DCS) provides the operator with the means to select which of the Conductivity Transmitter inputs will provide alarms and control. The output from the selected conductivity transmitter is sent to Controller H-261-OGQ-CC-3109 where it is compared to the setpoint of the controller (usually 120 mmhos/cm). The output signal provides blowdown of the Quench Recirc Tank when the conductivity reaches the specified level and continues the blowdown until conductivity reaches a specified lower level.

Filter Backpressure

DCS Controller/Indicator H-261-OGB-PIC-3716 controls backpressure on the filter by comparing actual pressure from H-261-OGB-PT-3716 to setpoint (approximately 60 psig, as set by the operator) and then positions Backpressure Valve H-261-OGB-PCV-3716.

Pump and Agitator Controls

All pumps and agitators except for the Blowdown Transfer Pumps and the Caustic Feed Pumps are controlled from DCS and local Manual/Off/Auto (MOA) Stations. The Blowdown Transfer pumps can only be operated from the local STOP/START pushbutton. The stroke (flow rate adjustment) of the Caustic Pumps can only be adjusted by manually operating the local stroke adjustment knob. Caustic Pump stroke time adjustments will vary the rate of addition of caustic to the affected sub-system, thereby affecting pH.

The field MANUAL-OFF-AUTO (M-O-A) Station is a three (3) position switch. There is also a "START" and "STOP" Pushbutton located near by.

An explanation of what occurs in each of the M-O-A switch positions follows:

"MANUAL" Position: When the switch is placed in manual the pump may be started by the start pushbutton. The pump can NOT be started or stopped by DCS controls. The only permissives required to start the pump are "hardwired." No permissives from the DCS are required to start the pump. No permissives are generated to complete a logic flowpath in DCS/PLC to perform an automatic or DCS started function when the pump is running.

"OFF" Position: When the switch is placed in off the pump stops. The pump can NOT be started by the start pushbutton. The pump can NOT be started by DCS controls.

"AUTO" Position: When the switch is placed in auto the pump may be started by the start pushbutton when the DCS/PLC permissives are present. The pump may be started from DCS if the required DCS/PLC permissives are present. The pump running generates a permissive signal for DCS/PLC if required.

ELO 3.07	**DESCRIBE the interlocks associated with the following OFFGAS System equipment to include the interlock actuating conditions, effects of interlock actuation, and the reason the interlock is necessary.** **a. Quench Vessel** **b. Scrubber** **c. Quench Recirculation Pumps** **d. Scrubber Recirculation Pumps** **e. Induced Draft Fans** **f. Caustic pumps**

Interlocks

Interruption or variations in the offgas process, beyond established limits, activate interlocks. An interlock generates a permissive and/or signal to open or close valves, start or stop pumps, or initiates a waste feed cutoff which will shutdown the incinerator. All interlocks are discussed with the associated instruments, but to emphasize the importance to safe plant operations, the following conditions that cause an incinerator interlock are addressed again below:

- Low Quench Recirc Flow;
- Both Quench Recirc Pumps not running;
- High temperature out of the Quench Vessel;
- Emergency Service or Fire Water to the Quench Vessel;
- Low-Low flow in Scrubber Recirculation Line;
- Both Scrubber Recirculation Pumps not running;
- High temperature in Scrubber;
- Emergency Fire Water to the Scrubber;
- Low-Low pH in Scrubber Recirculation Line;
- Low-Low steam flow to the Scrubber;
- High-High Steam Pressure;
- No ID Fans running;
- High-High CO level detected;

Limits

The maximum temperature and pressure of the Offgas System equipment is defined by the limits of the Fiberglass Reinforced Plastic (FRP) used to construct the Scrubber, Cyclone Separator and ductwork.

The cold start metal temperature heatup rate for the Reheater is 100 °F per hour.

Summary

- Control loops provide automatic control, by the DCS/PLC System for;

  caustic flows,

  Scrubber Recirc. flow,

  make up water,

  steam flows,

  maintaining system pressure,

  blowdown from Quench Recirc Tank,

  filter back pressure.
- Interruption or variations in the offgas process, beyond established limits, activate interlocks which open and close valves, start and stop pumps, and initiate incinerator shutdowns.
- The temperature and pressure of the Offgas System is defined by the limits of the FRP used to construct the Scrubber, Cyclone Separator and ductwork.

SYSTEMS INTERRELATIONS

ELO 2.02	**DESCRIBE the OFFGAS System arrangement to include a drawing showing the following system components and interfaces with other systems:** **a. OFFGAS Quench** **b. OFFGAS Scrubber** **c. OFFGAS Exhaust** **d. OFFGAS Blowdown**

Fire Water System

The Fire Water System provides emergency cooling water to both the Offgas Quench and the Offgas Scrubber in the event of a loss of normal cooling and Service Water. (H-261-FW-PV-3100A&B)

Plant / Instrument Air System

The Plant Air System supplies air for the following:

- keep clear the Quench Vessel emergency sprays. (H-261-PA-PV4515)
- motive force for backwashing the Crossflow Filter. (H-261-PW-PV3702)
- pressurize the OFFGAS System pump Thermosyphon reservoirs. (See P&ID)
- operate pneumatic equipment throughout the Offgas System, including tank bubblers, and ID Fan Dampers. (See P&ID)

Service Water System

Service Water is supplied as emergency cooling for the Quench Vessel and the Scrubber. In addition, Service Water supplies the following components for makeup, cleaning, or dilution:

- Quench Recirculation Tank (H-261-SW-V-093)
- Scrubber Recirculation Tank (H-261-SW-LCV-3301)
- Filter Feed Tank (H-261-SW-V-053)
- Mist Eliminator (H-261-SW-V037 ,038 ,039, & 040)
- Blowdown Hold Tanks 1 & 2 (H-261-SW-V048 & 042)
- Caustic System (H-261-SW-FV-0056)

Steam System

The Steam System supplies High Pressure (300 psig) steam to the Scrubber and Medium Pressure Steam (180 psig) to the Reheater. (H-261-MS-TCV-3401A&B)

In addition to the above mentioned applications, steam can also be supplied to the caustic tanker when receiving caustic to prevent solidification within the transfer line. (H-262-LS-V-007)

Summary

- The Offgas System interfaces with the Fire Water System and Service Water System for emergency cooling supply to both the Offgas Quench and the Offgas Scrubber.
- The Offgas System interfaces with the Plant Air System to maintain equipment operation and to the Quench Vessel for maintaining clear the emergency sprays nozzles.
- The Steam System supplies steam to the Scrubber, to the Reheater, and the caustic unloading equipment.

INTEGRATED PLANT OPERATIONS

ELO 4.02	**Given applicable procedures and plant conditions, DETERMINE the actions necessary to perform the following OFFGAS System operations;** **a. Normal Startup** **b. Normal/abnormal operation** **c. Normal Shutdown** **d. Mandatory Shutdown** **e. Emergency Shutdown**
ELO 4.03	**DETERMINE the effects on the OFFGAS System and the integrated plant response when given any of the following:** **a. Indications/alarms** **b. Malfunctions/failure of components** **c. Operator Actions**

Normal Startup

The procedure hierarchy for normal start-up Offgas System operations is:

- 261-GOP-01 Process Startup From Cold Standby to Warm Operations (U)
- 261-SOP-OGE-01; 261-SOP-OGB-01; 261-SOP-OGQ-01; 261-SOP-CAUS-02
- 261-SOP-INC-01 Incinerator Startup From Cold Standby to Warm Standby
- 261-GOP-02 Process Startup From Warm Standby to Normal Operations

A general outline of the actions required for the startup of the Offgas System follows:

- Fill the recirc tanks.
- Start one induced draft fan.
- Initiate steam flow through the Reheater.
- Initiate flow through the Scrubber system.
  - Open process water valve to tank.
  - Start tank agitator.
  - Select and start pump.
  - Open steam valve.
- Initiate flow through the Quench system.
  - Select and start primary recirc pump.
  - Select where the scrubber liquid makeup is to go.
  - Start quench tank agitator.

- Start second induced draft fan
- Start crossflow filter operation
    - Fill filter feed tank
    - Start agitator
    - Align valves
    - Start recirc pump
    - Initiate filtrate flow to quench.

Normal/abnormal operation

Normal operating mode is Mode 1, the facility is capable of performing its intended function. The CIF incineration system is allowed to receive solid and/or liquid wastes. The fuel oil burners are on, and the incineration system is above the minimum temperature for incineration of wastes. The Distributive Control System (DCS) should be in Alarm Mode 1. Abnormal operation is defined here as normal plant operations continuing with unplanned maintenance on an offgas component.

The procedures used for normal Offgas System operations is:

- 261-GOP-03 Process Normal Operations (U)
- 261-SOP-OGQ-01 261-SOP-OGS-01; 261-SOP-OGE-01; 261-SOP-OGB-01; 261-SOP-CAUS-01 & 02;
- 261-ROOR-O1 Rover Outside Operator Rounds (U)
- 261-ROR-01 R S Regulatory Operator Rounds
- 261-SUR-OG-01 Tank Sampling for Laboratory Analysis (U)
- 261-SUR-INC-02 Incinerator and OFFGAS Waste Feed Cutoff RCRA Surveillance Test R (U)
- 261-SOP-RMAC-01, Raw Materials Acceptance Criteria (U) addresses the acceptance criteria for caustic.

A general outline of the actions required for normal/abnormal operation of the Offgas System follows:

- Monitor system parameters on the DCS and on local instrumentation..
- Obtain samples as required
- Conduct required testing
- Assist maintenance
- Accept raw materials.

Normal Shutdown

Normal shutdown of the incinerator is a pre-planned activity and is not caused by malfunction or failure of a component of the incineration system or any support system. Scheduled maintenance requiring incinerator shutdown or a lack of waste feed materials are examples of normal shutdown. During the process of a normal shutdown, the CIF will be in the mode of Warm Standby.

The procedure hierarchy for normal shutdown Offgas System operations is;

- 261-GOP-04 Process Shutdown From Normal Operation to Warm Standby
- 261-SOP-INC-03 Incinerator Normal Shutdown
- 261- GOP-05 Process Shutdown From Warm Standby to Cold Standby
- 261-SOP-CAUS-02; 261-SOP-OGB-01; 261-SOP-OGS-01; 261-SOP-OGE-01; 261-SOP-CAUS-01;

A general outline of the actions required for the shutdown of the Offgas System follows:

- Shutdown Scrubber recirc pumps
- Shutdown Quench recirc pumps
- Shutdown steam to scrubber
- Shutdown one induced draft fan
- Shutdown remaining pumps
    - Caustic
    - Filter feed
    - Filter concentrate
    - Blowdown #1
    - Blowdown #2
- Shutdown Agitators (If required)
    - Blowdown #1
    - Blowdown #2
    - Filter feed
    - Quench recirc tank
    - Scrubber recirc tank
- Shutdown second induced draft fan

Mandatory Shutdown

A mandatory shutdown involves either the DCS or Operations personnel placing the facility in Warm or Cold Standby due to a component or system malfunction, or to avoid or respond to a violation or a permit or safety requirement.

The procedure hierarchy for a mandatory shutdown of the Offgas System operations is:

- The applicable 261-ARP-
- 261-AOP-OG-01
- 261-SOP-INC-04 Mandatory Incinerator Shutdown (U)
- 261-SOP-INC-03 Incinerator Normal Shutdown (U)
- 261- GOP-05 Process Shutdown From Warm Standby to Cold Standby
- 261-SOP-CAUS- 02; 261-SOP-OGB-01; 261-SOP-OGS-01; 261-SOP-OGE-01; 261-SOP-CAUS-01;

A general outline of the actions required during a mandatory shutdown would be dependent upon the reason, but may include;

- Locking out valves and drain pipes on either side of control valves, pressure relief valves filters and pumps.
- Assisting in HEPA filter "Bag in", "Bag out".
- Manipulating low point drains in process piping and ducts.
- Switching equipment from standby to primary.
- Selecting redundant instrumentation, ie. scrubber pH.
- Selecting local and or DCS pump control.
- Aligning valving to allow operating transfers among the blowdown system.

Emergency Shutdown

An emergency shutdown results from a condition in the CIF that could impact the health and safety of the personnel or potentially damage CIF equipment. An emergency shutdown involves either the DCS or CIF Operations personnel immediately placing the facility in Warm Standby and preparing the CIF for Cold Standby.

The procedure hierarchy for an emergency shutdown of the Offgas System operations is:

- The applicable 261-ARP-
- 261-AOP-OG-01
- 261-SOP-INC-05 Emergency Incinerator Shutdown (U)
- 261-SOP-INC-03 Incinerator Normal Shutdown (U)
- 261- GOP-05 Process Shutdown From Warm Standby to Cold Standby
- 261-SOP-CAUS- 02; 261-SOP-OGB-01; 261-SOP-OGS-01; 261-SOP-OGE-01; 261-SOP-CAUS-01;

An general outline of the actions required for an emergency incinerator shutdown is dependent upon the particular cause. For example, a general outline of actions required from a high temperature alarm out of the quench or scrubber is:

- Start emergency water to quench. (This is an automatic response but valves 261-FP-FV-4001 and 261-SW FV-4005 can be opened manually.)
- Start emergency water to scrubber. (This is an automatic response but valve 261-FP-FV-3000 can be opened manually.)
- Shut off steam to the scrubber (via DCS PT-OGS3009TS-1). This is an automatic response but valve H-261-HS-V-010 can be manually closed.
- Shutdown one Induced Draft Fan (via DCS PT-OGB3505E-1; 3506E-1; or 3513E-1) This is an automatic response but the operator can stop a fan with a local stop pushbutton.

Where as, the actions required upon electric power failure or normal power interruption are;

- The automatic transfer switches will move from normal position to emergency position upon loss of power with the Diesel Generators coming up to speed 10 seconds later.
- A start signal will be sent to the Quench Recirculation Pumps until one pump has successfully started.
- After one Quench Recirculation Pump has been running for 10 seconds, a start signal will be sent to the Scrubber Recirculation Pumps until one pump has successfully started.
- After one Scrubber Recirculation Pump has been running for 10 seconds, a start signal is sent to the ID Fans until one fan is started successfully.
- Control of the RK pressure is transferred from the Duct damper (H-261-OGS-FCD-1704) to the ID fan Integral dampers, the Duct damper is set to full open and transferred to MANUAL mode.
- After one Service Water Pump has been running for 10 seconds, a start signal will be sent to start Caustic Metering Pump No. 3208.

In order to recover to a point of system startup a general outline of the actions required is;

- Check pump, fan motors, agitator motors to assure they are operational.
- Check HEPA filter elements to assure they are not clogged or overloaded.
- Check manual valves for proper alignment.
- Proceed with system startup per procedure.

A listing of the main Offgas procedures and sections follows;

OGQ System

Operation of the OGQ System is controlled by 261-SOP-OGQ-01, Offgas Quench. The following operations are addressed in this procedure:

- System Alignment
- Quench Recirculation Tank Manual Fill
- Quench Normal Operations
- Swapping Quench Recir Pumps
- Swapping Quench Tank Probes
- Quench Blowdown Hold Tank Selection Auto Mode
- Transfer of Quench Water to BLOWDOWN Tank 001/002
- Transfer of Quench Water to Filter Feed Tank 003
- Quench Recir System Shutdown
- Draining Quench Recir Tank
- Flushing OGQ Pump and Suction Headers

OGS System

Operation of the OGS System is controlled by 261-SOP-OGS-01, Offgas Scrubber. The following operations are addressed in this procedure:

- System Alignment
- Offgas Scrubber Recirculation Tank Fill and Startup
- Offgas Scrubber Operations
- Emergency Offgas Scrubber Spray Operation
- System Shutdown

OGE System

Operation of the OGE System is controlled by 261-SOP-OGE-01, Offgas Exhaust. The following operations are addressed in this procedure:

- System Alignment
- Reheater Operation
- Induced Draft Fan Operation with One Fan
- Induced Draft Fan Operation with Two Fans
- Removing a Filter Bank from Service
- Removing a Reheater Steam Coil from Service
- System Shutdown

OGB System

Operation of the OGB System is controlled by 261-SOP-OGB-01, Offgas Blowdown. The following operations are addressed in this procedure:

- System Alignment
- Filter Feed Tank Fill and Operation
- Crossflow Slurry Filter Operation
- Crossflow Slurry Filter Backwash
- Transfer of Filter Feed Tank to Blowdown Hold Tank
- Removing Crossflow Slurry Filter from Service
- Blowdown Hold Tank No. 1 Fill and Operation
- Blowdown Hold Tank No. 2 Fill and Operation
- Blowdown Hold Tank No. 1 Recirculation
- Recirculation of Blowdown Hold Tank No. 1 using Blowdown Transfer Pump No. 2
- Blowdown Hold Tank No. 2 Recirculation
- Recirculation of Blowdown Hold Tank No. 2 using Blowdown Transfer Pump No. 1
- Transfer of Blowdown Hold Tank No. 1 to Blowdown Hold Tank No. 2
- Transfer of Blowdown Hold Tank No. 2 to Blowdown Hold Tank No. 1
- Transfer of Blowdown Hold Tank No. 2 to the Tanker Truck using Blowdown Transfer Pump No. 2
- Transfer of Blowdown Hold Tank No. 2 to the Tanker Truck using Blowdown Transfer Pump No. 1
- Caustic Addition to the Blowdown Hold Tanks
- Transfer of Blowdown Hold Tank No. 2 to the tanker truck using Blowdown Transfer Pump No. 2
- Blowdown Hold Tank No. 1 Sampling

- Blowdown Hold Tank No. 2 Sampling
- Filter Feed Tank Sampling

Caustic System

Operation of the Caustic System is controlled by 261-SOP-CAUS-01, Caustic (U) and 261-SOP-CAUS-02, Caustic Treatment (U). The following operations are addressed in these procedures:

SOP-CAUS-01

- System Alignment
- Ordering Caustic
- Receiving Caustic from the Tanker Truck

SOP-CAUS-02

- System Alignment
- Placing Caustic in Service to the Offgas Scrubber System Using Caustic Pump No. 1/ No. 2
- Placing Caustic in Service to the Offgas Scrubber System using Caustic Pump No. 3208
- Placing Caustic in Service to the Offgas Quench Recirculation Tank
- Placing Caustic in Service to the Offgas Quench Recirculation Tank using Caustic Pump No. 3208
- Placing Caustic in Service to the Blowdown Hold Tanks
- Shutdown of Caustic System
- System Operation on Emergency Power

SOP-RMAC-01

261-SOP-RMAC-01, Raw Materials Acceptance Criteria (U) addresses the acceptance criteria for caustic.

Summary

- Normal operation of the facility in controlled by the GOP's, SOP's, SUR's and operator rounds.
- Mandatory and emergency shutdowns are controlled by ARP's, AOP's, SOP's, and GOP's.
- A mandatory shutdown involves either the DCS or Operations personnel placing the facility in Warm or Cold Standby due to a component or system malfunction, or to avoid or respond to a violation or a permit or safety requirement.
- An emergency shutdown results from a condition in the CIF that could impact the health and safety of the personnel or potentially damage CIF equipment. An emergency shutdown involves either the DCS or CIF Operations personnel immediately placing the facility in Warm Standby and preparing the CIF for Cold Standby.
- The general actions in the Offgas system, upon electric power failure or normal power interruption are;

  A start signal is sent to the ID Fans until one fan is started successfully.

  After one ID Fan has been running for 10 seconds, a start signal will be sent to the Quench Recirculation Pumps until one pump has successfully started.

  After one Quench Recirculation Pump has been running for 10 seconds, a start signal will be sent to the Scrubber Recirculation Pumps until one pump has successfully started.
- The operator actions required from a high temperature alarm out of the quench or scrubber are:

  Start emergency water to quench. (This is an automatic response but the valves 261-FP-FV-4001 and 261-SW FV-4005 can be opened manually.)

  Start emergency water to scrubber. (This is an automatic response but the valve 261-FP-FV-3000 can be opened manually.)

  Shut off steam to the scrubber (via DCS PT-OGS3009TS-1) This is an automatic response but valve H-261-HS-V-010 can be manually closed.

  Shutdown one Induced Draft Fan (via DCS PT- OGB3505E-1; 3506E-1; or 3513E-1) This is an automatic response but the operator can stop a fan with a local stop pushbutton.

APPENDIX A - Offgas System Alarms

ALARM	SETPOINT
Scrubber Inlet Temperature Hi	200 °F
Scrubber Inlet Temperature Differential	10 °F
Scrubber Inlet Temperature Hi-Hi	210 °F
Scrubber Differential Pressure Hi	4 in. WC
Steam to Scrubber Flow Lo-Lo	6000 lb/hr
Steam to Scrubber Flow Lo	7000 lb/hr
Steam to Scrubber Pressure Lo	200 psig
Scrubber Outlet Temperature Hi	200 °F
Scrubber Outlet Temperature Differential	10 °F
Scrubber Outlet Temperature Hi-Hi	210 °F
Quench Recirc Tank Level Lo-Lo-Lo	18 in.
Quench Recirc Tank Level Lo	65 in.
Quench Recirc Tank Level Hi	85 in
Quench Recirc Tank Level Hi-Hi	96 in.
Quench Recirc Pump Auto Start	N/A
Quench Recirc pH Lo	5.0 pH
Quench Recirc pH Hi	7.5 pH
Quench Recirc pH Xmtr Differential	0.5 pH Diff
Quench Recirc pH Flow Lo	4 gpm
Quench Recirc Temperature Hi	200 °F
Quench Recirc Conductivity Hi	350 µS/cm
Quench Recirc Conductivity Differential	50µS/cm

APPENDIX A- Offgas System Alarms (cont.)

ALARM	SETPOINT
Scrubber to Cyclone Separator DP Hi	35 INWC
Cyclone Separator Level Hi	ACTUATE
Mist Eliminator DP Hi	4 in. WC
Cyclone Separator Outlet Pressure Hi Cyclone Separator Outlet Pressure Hi-Hi	-2.5 in. WC -1.0 in. WC
Cyclone Separator Drain pH Lo	6.0 pH
Cyclone Separator Drain pH Hi	7.5 pH
Cyclone Separator Drain pH Xmtr Diff.	0.5 pH Diff
Quench Vessel 1st Header Flow Lo	60 GPM
Quench Vessel 2nd Header Flow Lo	60 GPM
Quench Vessel 3rd Header Flow Lo	60 GPM
Quench Vessel 4th Header Flow Hi	14 GPM
Quench Vessel 5th Header Flow Lo	100 GPM
Scrubber Recirc pH Lo	6.0 pH
Scrubber Recirc pH Hi	8.0 pH
Scrubber Recirc pH Xmtr Differential	0.5 pH Diff
Scrubber Recirc pH Lo-Lo	NA
Scrubber Recirc Tank Level Lo-Lo-Lo	18 in. WC
Scrubber Recirc Tank Level Lo-Lo	30 in
Scrubber Recirc Tank Level Lo	30 in
Scrubber Recirc Tank Level Hi	102 INWC
Scrubber Recirc Tank Level Hi-Hi	NA

APPENDIX A- Offgas System Alarms (cont.)

ALARM	SETPOINT
Scrubber Recirc Pump Auto Start	N/A
Scrubber Recirc Conductivity Hi	350 µS/cm
Scrubber Recirc Conductivity Xmtr Diff.	250 µS/cm
Scrubber Recirc Flow Lo-Lo	20 gpm
Scrubber Recirc Flow Lo	30 gpm
Scrubber Recirc Flow Hi	70 gpm
Scrubber Recirc Density Hi	1.3 SPG
Scrubber Recirc Temperature Hi	190 °F
Scrubber Recirc to Quench Flow Lo	25 gpm
Scrubber Recirc pH Flow Lo	4 gpm
Reheater DP Hi	4 in. WC
Reheater Outlet Temperature Lo	205 °F
Reheater Outlet Temperature Hi	260 °F
Reheater Outlet Temperature Hi-Hi	265 °F
HEPA Filter DP Hi	10 in. WC
ID Fan Inlet Pressure Lo	-20 in. WC
ID Fan Inlet Pressure Hi	-10 in. WC
CO Level Hi	125 ppm
CO Level Hi-Hi	100 ppm/1 hr
CO/O2 Common Fault	N/A
O2 Level Lo	8 %
O2 Level Hi	12 %

APPENDIX A - Offgas System Alarms (cont.)

ALARM	SETPOINT
ID Fan #1 Auto Start	N/A
ID Fan #2 Auto Start	N/A
ID Fan #3 Auto Start	N/A
ID Fan #1 Vibration Hi	NA
ID Fan #2 Vibration Hi	NA
ID Fan #3 Vibration Hi	NA
Duct to Stack Temperature Lo	200 °F
Duct to Stack Temperature Hi	255 °F
Filter Feed Tank Level Lo-Lo-Lo-Lo	12 in.
Filter Feed Tank Level Lo-Lo-Lo	18 in.
Filter Feed Tank Level Lo-Lo	24 in.
Filter Feed Tank Level Lo	30 in
Filter Feed Tank Level Hi	102 in.
Filter Feed Tank Level Hi-Hi	108 in.
Filter Feed Tank Level Hi-Hi-Hi	NA
Filter Recirc Flow Lo	200 GPM
Filter Recirc Density Hi	1.0 PSID
Filter Recirc Density Hi-Hi	1.3 SPG
Service Water (to Filter Feed Tank) Filter DP Hi	10 psid
Filter Feed Pump Auto Start	N/A
Filtrate Flow Lo	.35 gpm
Backwash Trouble	N/A

APPENDIX A - Offgas System Alarms (cont.)

ALARM	SETPOINT
Filter Pressure Lo	50 psig
Filter Pressure Hi	75 psig
Blowdown Hold Tank 1 Level Lo-Lo	18 in.
Blowdown Hold Tank 1 Level Lo	22.92 in.
Blowdown Hold Tank 1 Level Hi	102 in.
Blowdown Hold Tank 1 Level Hi-Hi	108 in.
Blowdown Hold Tank 1 Level Hi-Hi-Hi	108 in.
Caustic Tank Temperature Lo-Lo	65 °F
Caustic Tank Temperature Hi-Hi	100 °F
Caustic Tank Level Hi-Hi-Hi	105 in.
Caustic Tank Level Lo-Lo-Lo	1160 GALLONS
Caustic Tank Level Lo-Lo	1450 GALLONS
Caustic Tank Level Lo	1741 GALLONS
Caustic Tank Level Hi	102 in.
Emergency Service Water Pressure Lo	26 psig
SCC to Quench DP High	10 in. WC
Quench Recirc Flow Lo	296 GPM
Quench Recirc Density Hi	1.3 SPG
Quench Vessel Level Hi	2 in. WC
Blowdown Hold Tank 2 Level Lo-Lo	14 in.
Blowdown Hold Tank 2 Level Lo	24 in.
Blowdown Hold Tank 2 Level Hi	102 in.

APPENDIX A - Offgas System Alarms (cont.)

ALARM	SETPOINT
Blowdown Hold Tank 2 Level Hi-Hi	105 in.
Blowdown Hold Tank 2 Level Hi-Hi-Hi	105 in.
Offgas Duct Flow Lo	7,500 SCFM
Offgas Duct Flow Hi	16,644 SCFM
Offgas Isokinetic Radiation Hi (DCS)	1000 CPM
Offgas Isokinetic Radiation Hi (Local)	1000 CPM
Offgas Sample 1 Flow Lo	.95 SCFM
Offgas Sample 1 Flow Hi	2.67 SCFM
Offgas Sample 2 Flow Lo	.95 SCFM
Offgas Sample 2 Flow Hi	2.67 SCFM
Offgas Isokinetic System Trouble	N/A
Quench Pump(A) Seal Tank, Pressure, Low	20 PSIG
Quench Pump(B) Seal Tank, Pressure, Low	20 PSIG
Scrubber Pump(A) Seal Tank, Pressure, Low	19 PSIG
Scrubber Pump(B) Seal Tank, Pressure, Low	19 PSIG
Filter Conc. Pump Seal Tank, Pressure, Low	19 PSIG
Blowdown. Transfer Pump(A) Seal Tank, Low Pressure	19 PSIG
Blowdown. Transfer Pump(B) Seal Tank, Low Pressure	19 PSIG
Filter Feed Pump(A) Seal Tank, Pressure, Low	19 PSIG
Filter Feed Pump(B) Seal Tank, Pressure, Low	19 PSIG

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